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RECENT ADVANCES IN THE POTTERY INDUSTRY.

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THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XI.

THE revelations of the Centennial Exhibition set our potters to thinking and stimulated them to greater competition. Never before was such an impetus given to any industry. The best productions of all nations were sent here and exhibited beside our own modest manufactures, and it was only too apparent that America had been left behind in the race. Up to that time there had been a few sporadic instances of attempts at originality, but comparatively little had been accomplished of a really artistic nature. The existence of a true ceramic art in this country may be said to have commenced with the fair of 1876, because greater progress has been made within the fifteen years which have elapsed since that important event than during the two centuries which preceded it. Let us see what rapid strides have been made in this period.

At the United States Pottery in Bennington, Vt., was a young man, Mr. L. W. Clark, son of the superintendent, Mr. Decius W. Clark, who, on the closing of that factory, accompanied his father to Peoria, Ill., and remained with the firm of Fenton & Clark for about two years, when he left to enter the army. In 1875 he went to Boston, and, in partnership with Mr. Thomas Gray, assumed control of the New England Pottery. This establishment was founded in 1854 by Mr. Frederick Meagher, who made Rockingham and yellow ware. It was afterward taken by Mr. William H. Horner, from whom the plant was purchased by the present proprietors, who now produce the usual lines of useful services in cream-colored and white granite ware. For the past five years

they have been making a decorated product in colored bodies, to which they have given the name "Rieti" ware. This is a semi-porcelain, finished and decorated chiefly after the Doulton, Adderley, and Worcester methods. They also make true hard porcelain of an admirable quality, and their goods are characterized by an artistic style of decoration and excellence of glaze, their mazarine blue and "old ivory" finish being especially praiseworthy. The decorating branches are under the direct supervision of Mr. J. W. Phillips, who originates and engraves many of the best designs used in their printing processes. Most of their shapes are utilitarian rather than ornamental, but they have succeeded in imparting to these a grace of outline and delicacy of coloring which render them objects of great beauty. Their chocolate-jugs, *jardinières*, and cuspidors compare very favorably with the imported wares, after which they are to some extent patterned. Of the few purely decorative forms which they have attempted, a semi-porcelain vase, twenty inches in height, made in 1889, is particularly meritorious. This is artistically painted in natural colors on raised paste, the top and base being in solid, dead gold. Mr. Bands, of the Royal Worcester Works, England, was the artist.

FIG. 18.—SEMI-PORCELAIN VASE.
New England Pottery Company, 1889.

The Ott and Brewer Company, of Trenton, N. J., now operates the factory which was built by Messrs. Bloor, Ott & Booth, in 1863. Mr. J. Hart Brewer, president of the company, entered the firm in 1865, and, being an artist himself of considerable ability, soon made his influence felt in the improvement of methods and elevation of standards. Until 1876 the chief products of this factory consisted of white granite and cream-colored ware. At the Centennial Exhibition the company made a display of a series of artistic Parians which had been designed mainly by Mr. Isaac Broome, an American artist of remarkable versatility and great promise. Of these special pieces,

probably the most noteworthy are a bust of Cleopatra and a vase with modeled figures of base-ball players.

The first attempts in the manufacture of "Belleek" egg-shell china were made by Mr. Brewer in 1882, in conjunction with Mr. William Bromley, Jr., but these early trials were not entirely satisfactory. Encouraged by partial success, however, Mr. Brewer induced Bromley to send for his father, William Bromley, and his brother, John Bromley, who, with two or three other hands, came over in the following year from the Belleek factory in Ireland. Mr. William H. Goss, of Stoke-on-Trent, invented this body some thirty years ago, at which time the elder Bromley was acting as his manager. Messrs. David McBirney and Robert Williams Armstrong were then attempting to make first-class ceramic goods at their recently established manufactory in the village of Belleek, county of Fermanagh, Ireland. Mr. Armstrong induced Bromley to take a number of Mr. Goss's best workmen to Ireland and introduce the egg-shell porcelain there. The ware produced at that factory has since become world-famous, being characterized by extreme lightness of body and a beautiful, lustrous glaze.

FIG. 19.—BELLEEK VASE. Ott and Brewer Company.

The ware now manufactured by the Ott and Brewer Company is made entirely from American materials, and is a vast improvement over the body and glaze first introduced by the Bromleys eight years ago. In the rich iridescence of the nacreous glaze it is fully equal to the original Belleek; in delicacy of coloring and lightness of weight it is even superior. A dozen cups and saucers, making twenty-four distinct pieces of the ordinary size, almost as thin as paper, weigh just one pound avoirdupois, or an average of only two thirds of an ounce each. A large variety of forms of this porcelain are produced, in both ornamental and useful designs. The larger vases are usually simple in outline and of the same comparative lightness as those of smaller size. They often possess pierced necks, feet, and handles, and are elegantly decorated in enamels, gold relief, and chasing.

A triumph of the potter's skill is a Belleek ostrich-egg bonbon-box, in two segments, which is exquisitely perforated or honeycombed over its entire surface. We can not here reproduce more than one or two examples of these beautiful fabrics. One is a

large vase of the "Bourne" pattern, decorated in raised gold and colors. The shape is graceful and the decoration is exceedingly artistic (Fig. 19).

In addition to art porcelains, this factory produces a great quantity of granite ware and opaque china, in dinner, tea, and toilet sets, which are both print-decorated and hand-painted. A *jardinière* of white granite, which we here figure, is a refined example of artistic decoration in quiet tones.

One of the most extensive establishments in the Eastern States is that of the Willets Manufacturing Company of Trenton, N. J.

FIG. 20.—WHITE GRANITE JARDINIÈRE. Ott and Brewer Company.

The present proprietors, Messrs. Joseph, Daniel, and Edmund R. Willets, three brothers, succeeded to the business in 1879. The factory was erected in 1853 by William Young and Sons, who at first made Rockingham and common ware. At the Centennial Exhibition William Young's Sons made a display of crockery and porcelain hardware trimmings, at which time the plant included only four kilns. The business has since grown to such an extent, under the present management, that there are now thirteen large ware kilns besides those used for decorating. The products from these works include sanitary earthenware, plumbers' specialties, white and decorated pottery, opaque china, white granite, and art porcelain. A specialty in dinner and toilet services is underglaze decoration on white bodies.

After the Ott and Brewer Company had perfected the body and glaze of their Belleek ware and got it well under way, William Bromley, Sr., went with the Willets Manufacturing Company and instructed them in the process. The manufacture of

white egg-shell ware, to which they are constantly adding new designs, is another specialty of these works, and the company is now competing successfully with the Dresden and other foreign factories in supplying white art porcelain to decorators. In form their pieces are graceful and artistic, one of which is represented in Fig. 22.

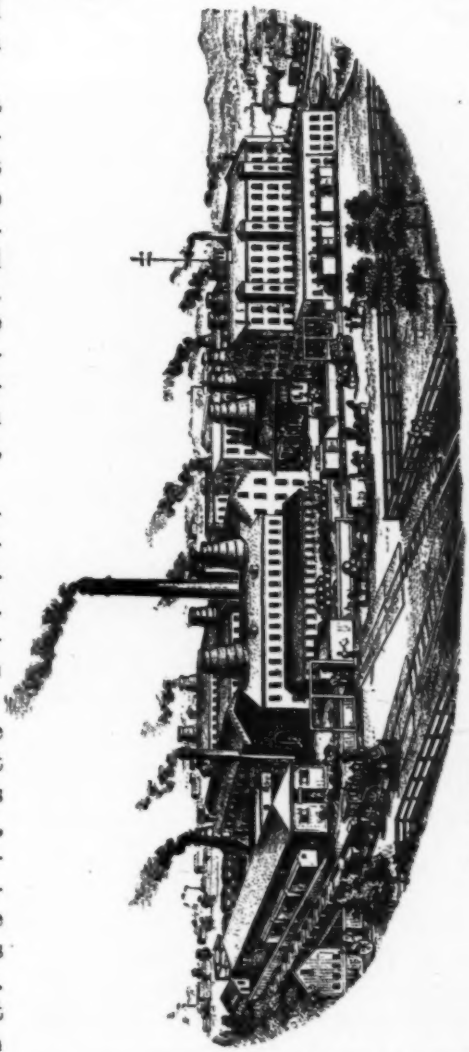

FIG. 21.—WORKS OF THE WILLETS MANUFACTURING COMPANY, TRENTON, N. J.

They also employ a number of competent artists to decorate their art goods, many of which are reproductions of the characteristic shell and coral forms of the Irish works. Fig. 23 represents a large Belleek vase with open-work handles and chrysanthemum decoration in delicate tints on an ivory, gold-stippled ground.

The Ceramic Art Company, of which Mr. Jonathan Coxon, Sr., is president and Mr. Walter S. Lenox secretary and treasurer, was established in Trenton in 1889. The first named gentleman became superintendent at the Ott and Brewer Company's works after Bromley left, and the latter was formerly in charge of their decorating department. Here they learned the processes of manufacturing Belleek. Although they have at present but one ware kiln and two decorating kilns, they are rapidly making a name by their constantly increasing patterns, many of which are exquisitely conceived and show the touch of a thorough artist. They have procured the best designers and painters that can be found and employ both the overglaze and underglaze processes in decorating. Their egg-shell ware is also furnished in the white to decorators. Fig. 24 shows one of these undecorated pieces, a graceful lily-shaped cup and saucer. In addition to vases and table pieces, they

make many fancy patterns, such as thimbles, inkstands, parasol-handles, menu slabs, and candelabra.

The Phœnixville (Pa.) Pottery, Kaolin, and Fire-brick Company was organized in 1867, and a few years later was succeeded by Messrs. Schreiber & Co., who made yellow and Rockingham ware, and terra-cotta ornaments and wall-pieces. Heads of hounds and stags in several sizes, and large boars' heads, were made extensively here, and twenty years ago were in demand for decorating the interiors of public-houses. Many of these may still be seen in country taverns. These were considered works of considerable artistic merit when first produced. The antlers and horns of stags and antelopes were made separately and afterward inserted. Messrs. Beerbower & Griffen took the pottery in 1877 and commenced the manufacture of white granite. In 1879 the firm name was changed to Griffen, Smith & Co., and in the following year the manufacture of "Etruscan" majolica was added. From 1880 to 1890 the factory produced a good grade of white and decorated china, mostly in table services and toilet sets. Through their majolica and "stucco" productions, however, the firm became more widely known, and within the past few years they have made many decorative pieces in shell and dolphin patterns, after the Irish Belleek forms. Since the fire, which destroyed a large portion of the works recently, the manufacture of majolica has been discontinued. Mr. Smith withdrew from the firm in 1889 and erected levigating mills at Toughkenamon, Pa., near which place are large beds of kaolin. The firm style was then changed to Griffen, Love & Co.

FIG. 22.—SHELL AND CUPID PITCHER—BELLEEK. Willets Manufacturing Company.

As early as 1882 experiments were commenced in the manu-

facture of hard porcelain, and a series of sample pieces were made for the New Orleans Exhibition. The quality and designs of these trial pieces were creditable, and the experiment has shown that this factory is capable of producing true porcelain of a high order. One of the New Orleans pieces, a pitcher of thin semi-transparent body, was also made in white earthenware, glazed and gilded, the latter of which is reproduced in Fig. 25. It is in the shape of a canteen, the mouth representing the head of a Continental soldier. The raised designs are flesh-colored, on a solid gold ground. The three-cornered hat is black. Mr. Scott Callowhill, an English artist of ability, was employed for a while in modeling and painting, but recently left, to accept a position with the Providential Tile Works of Trenton.

At the beginning of the present year a change was made in the proprietorship, and a new company has been incorporated, under the title of the Griffen China Company, which will hereafter make a specialty of fine translucent French china, in plain white table services. The company will also, at an early day, manufacture fancy tiles, under the direction of Mr. A. D. Vitan, a practical French potter, formerly at Greenpoint, Long Island. This gentleman has just perfected an improved machine for manufacturing art tiles, and another for making plates.

FIG. 23.—LARGE VASE—CHRYSANTHEMUM DECORATION. Willets Manufacturing Company.

The Borroughs and Mountford Company commenced business in Trenton in 1879, in what was formerly the Eagle Pottery. Their specialties are vitrified, thin, and hotel china, and underglaze printing on pottery and porcelain. The mechanical application of decorations is the distinguishing characteristic of one line of their art potteries, which, while closely imitating the more expensive methods of hand-painting, enables them to produce highly artistic effects at a greatly re-

duced cost. The bold ornamentation of their *jardinières*, umbrella-jars, punch-bowls, and vases, after the Doulton, Royal Worcester, and Adderley methods, bears a striking individuality of its own. Probably their most beautiful pieces are those on which raised gold designs are applied by hand to an exquisite mazarine blue. White tiles of the finest quality, with underglaze blue printed devices, as well as embossed and art tiles, are also made to some extent.

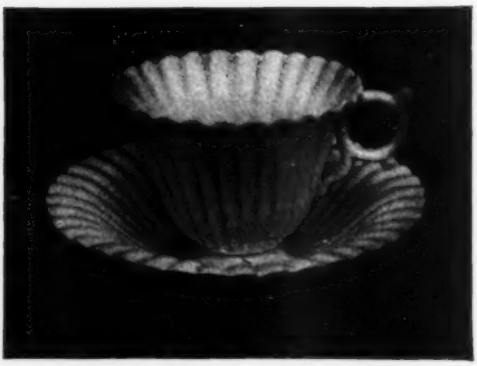

FIG. 24.—EGG-SHELL PORCELAIN—THE "ENGAGEMENT" CUP AND SAUCER. Ceramic Art Company.

The Greenwood Pottery Company, incorporated in Trenton in 1868, make a specialty of the manufacture of vitrified and translucent china for hotel, steamship, and railway uses. This pottery was established in 1861, under the style of Stephens, Tams & Co. They are also making, at the present time, thin china table ware for domestic purposes, porcelain hardware trimmings, and electrical, telegraph, and telephone insulating supplies. Some years ago they added an art department to their extensive establishment, and their decorated productions are characterized by elegance of form, being decorated usually in the Royal Worcester style, with ivory finish and raised gold, silver, and bronze effects. The plant of the company consists of seventeen large kilns, with an annual producing capacity of over half a million dollars.

FIG. 25.—WHITE-WARE PITCHER. Phœnixville, Pa.

Among the other important Trenton establishments is that of Messrs. Oliphant & Co., which turns out large quantities of plumbers' sanitary appliances, druggists' and jewelers' supplies. About 1886 the late Mr. Thomas Connolly, a partner in the concern, commenced experimenting in Belleek wares, having been at one time connected with the Irish works. He succeeded in producing some exquisitely thin trial pieces, and demonstrated the fact that these works could manufacture egg-shell ware of the highest grade. The few pieces which were produced, consisting

of small ewers, cups and saucers, were fired in the large kilns with the sanitary ware. For some unknown reason, however, this

FIG. 26.—EWER VASE. Faience Manufacturing Company.

branch of the business was never developed beyond the experimental stage.

The Knowles, Taylor and Knowles Company, of East Liverpool, Ohio, have the largest works in America, their plant covering ten

acres and including thirty-five ware and decorating kilns. The business was started in 1854 by Mr. Isaac W. Knowles and Mr. Isaac A. Harvey, who, with a single kiln, made yellow ware and, later, Rockingham. In 1870 Mr. Knowles, who had purchased the interest of his former partner, was joined by Messrs. John N. Taylor and Homer S. Knowles, and in 1872 they commenced the manufacture of iron-stone china and white granite ware. The business of the company has had a phenomenal growth, and at the present time they employ about seven hundred hands in the production of extensive lines of white granite and vitreous hotel china, which they supply to the trade.

The Faience Manufacturing Company, of Greenpoint, Long Island, produces white ware artistically decorated and, we believe, a limited quantity of porcelain. The pieces are of ornamental rather than of useful shapes. The engraving (Fig. 26) represents a ewer vase from this factory with open-work handle and molded figure of bird. It is unfortunate that the secrets of this factory should be guarded so jealously as to deprive us of all knowledge concerning the processes employed and the qualities of the wares produced. Repeated inquiries have failed to elicit any reply.

To Mr. Thomas C. Smith, of Greenpoint, Long Island, belongs the honor of being the first American manufacturer who has been successful in placing upon the market a true hard porcelain as a commercial article. His experiments, which extended over a number of years, first commenced to bear fruit about 1865, when he perfected a plain white ware, and a year afterward he commenced to decorate his goods. The Union Porcelain Works, of which Messrs. Thomas C. Smith and C. H. L. Smith are the proprietors, have produced many decorative pieces in addition to their staple productions of true porcelain table ware.

This porcelain is composed in body of clay, quartz, and feldspar. It is fired in biscuit at a low temperature, in the second story of the porcelain kiln, using for its baking the surplus heat passing away after having done its greater work in the first story or gloss-kiln where the glazing is done. At this first burning the ware receives only sufficient fire to make it properly fasten together in form. It is quite fragile, easily broken with the fingers, and porous, not having yet had sufficient heat to commence vitrification. In this condition it is what is termed porcelain biscuit, and is ready for the glaze-tub. The glaze of porcelain is composed of the same material as the body, and so compounded that those elements which are soonest fluxed by the influence of the heat are in greater proportion than they are contained in the body. The porous, low-fired biscuit is dipped into a liquid puddle of glaze. Upon being withdrawn its porosity quickly absorbs the excess of water, leaving a dry coating of the glaze compound,

which was held by the water in suspension, upon the surface of the piece. This piece of porous biscuit covered with glaze is now cleaned of glaze upon its foot, or that part upon which it rests, to prevent its sticking or burning fast to the clay "sagger" or firing case; otherwise the glaze on the bearing parts would, at the time of flowing, form a cement, fastening the piece and the sagger together. The pieces are placed separately in the saggers. The heat in firing hard porcelain is carried to such a high degree that the ware touches the point of pliability, almost the melting-point. At this point of heat the body is vitrified; at the same time the glaze, from its slightly softer composition, is melted into the body of the ware, producing a hard, vitreous, and homogeneous material properly known as true, hard porcelain. This is the process used at Sèvres, Meissen, Berlin, and elsewhere.

Fig. 27.—Bust of Edwin Forrest as William Tell. Union Porcelain Works.

The earthenware method is just the reverse of this. The body is composed of much the same materials as a porcelain body, but differently compounded, and it is baked in biscuit at the first firing at a greater heat than is required for porcelain biscuit, and receives during that first burning the greatest heat to which it is subjected in the entire process of manufacture. The glaze is composed partly of the same materials as compose the body, with the addition of oxide of lead and boracic acid, which latter, being soft, fluxes in the fire, enabling the glaze to flow at a low heat. It is fired the second time in the gloss-kiln at a lower temperature than it has previously been fired in biscuit. This results in flowing the soft glaze over the surface of the ware, making substantially a lead-glass film or coating upon the surface of different compounds and materials, not homogeneous, not a part of the

ware by being fused into the body as in porcelain. The body and glaze being thus in constant antagonism to each other, produce sooner or later what is technically called "crazing" or cracking of the enamel, for the reason that the body is one thing, produced

FIG. 28.—TÊTE-À-TÊTE SET. Union Porcelain Works.

at a higher temperature, and the glaze another, produced at a lower temperature, and not as in porcelain, body and glaze produced at the same time, and at the last and greatest heat.

Fig. 28 shows a *tête-à-tête* set, with head of Chinaman on the cover of the tea-pot, a negro's head on the sugar-bowl, and goat's head on the creamer.

The Union Porcelain Works also manufacture largely hard porcelain insulators and hardware trimmings.

The exquisite fabrications of the Greenpoint works have done much to dispel that unreasonable prejudice which until recently condemned all American productions, of whatsoever merit.

Beautiful as are many of the delicate productions of the potter's skill which are made in molds or by the aid of machinery, clay is a material which yields the most subtle and satisfactory results to the direct touch of the human hand. While printing processes are excellent in their way and indispensable for cheapness, where large production is an element to be considered, they are inadequate to give that breadth and freedom of treatment which constitute true artistic decoration.

While visiting the Centennial, Miss M. Louise McLaughlin, of Cincinnati, was strongly impressed with the beauty of the then novel faience from the Haviland potteries of Limoges, and on her return home she determined to discover, if possible, the processes of decoration. Her experiments, partially successful, extended over a period of nearly three years, and in April, 1879, she gathered around her twelve ladies who were interested in decorative art, and the Pottery Club, which has since exercised such an important influence on the ceramic industry in Cincinnati, was then organized, Miss McLaughlin being elected president and Miss Clara Chipman Newton secretary. Experiments were continued at some of the city potteries, where red, yellow, and white wares were made. On the unburned ware colored clays were applied in the manner of oil paints, and some satisfactory results were obtained.

The ceramic display of Japan at the Philadelphia Exhibition was, more than any other perhaps, the artistic impulse that inspired the venture which resulted in the establishment of the Rookwood Pottery in 1880 by Mrs. Maria Longworth Nicholls. Her experiments were continued at this factory, which, through the liberal patronage of Mr. Joseph Longworth, her father, was furnished with the necessary means for carrying it on until its productions had found a market and it could stand financially alone.

The ware produced here is a true faience, and while the shapes employed are mainly reproductions or variations of classic Greek forms, they possess a marked originality in treatment. The potter's wheel is used as far as possible, on account of giving more freedom and greater variety to the outlines. Mr. Charles Mahar is the only thrower employed at the pottery, and his graceful creations have obtained a world-wide celebrity. The method of casting in vogue is that which consists in pouring liquid clay into plaster molds, which absorb the superabundant moisture from the

adjacent clay. The thin slip is then emptied from the center of the molds, leaving a shell of uniform thickness, which is allowed to stand a while longer before being removed.

The bodies are made of clays found mainly in the Ohio Valley, though samples are being constantly sent to Mr. Joseph Bailey, the superintendent, from all parts of the country. The clays mostly used are a red variety from Buena Vista, Ohio; yellow from Ironton, Ohio; and a whitish or cream-colored clay from Chattanooga—artificially tinted bodies being also used to some extent. The glazing, however, is the most distinctive characteristic of the Rookwood Pottery, which, when applied to the tinted

FIG. 29.—GROUP OF ROOKWOOD VASES.

bodies, produces the effect of rich tones of black, yellow, green, red, brown, and amber, harmoniously blended, of great depth and strength. A number of competent artists are constantly employed in beautifying the wares, the decorations being entirely underglaze. Mr. Kataro Shirayamadani, a Japanese painter of the best school, is doing some of the finest work in Oriental methods. Mr. A. R. Valentien, Mr. M. A. Daly, and others rank among the best American decorators in their particular lines. The above engraving will give a fair idea of some of the forms of vases produced, but no adequate conception of the great beauty of the glazing can be conveyed in black and white.

It is not generally known that the Rookwood Pottery has produced varieties of ware other than the richly glazed pottery which has recently become so familiar through its exhibition in the prominent art-stores of the country. In the earlier years, commencing about 1881, cream-colored ware, with blue prints of

fishes and reptiles, was made. One of these early plates so decorated is here figured. Yellow ware of the finest quality was also produced ten years ago. The highest achievements in glazing are the so-called tiger's-eye and gold-stone, which glisten in the light with an auriferous sheen and all the changing hues of the rainbow.

The Rookwood Pottery was the first in this country to demonstrate the fact that a purely American art-production, in which original and conscientious work is made paramount to commercial considerations, can be appreciated by the American public; for financially this enterprise has recently proved successful, and under the efficient management of Mr. W. W. Taylor, the enthusiastic president of the company, experiments are being constantly prosecuted to discover new bodies, colors, and glazes. At the present time a new building, with improved equipments, is being erected on the summit of Mount Adams, which, it is expected, will be ready for occupancy before the end of the present year.

FIG. 30.—ROOKWOOD PLATE, PRINTED DECORATION.

Within the past few years other potteries have attempted in Cincinnati to make decorated ware, with varying success. One founded by Mr. M. Morgan produced a faience modeled in low relief, in Moorish designs, and the Avon Pottery commenced the manufacture of a ware somewhat resembling the Rookwood; but both were closed after a brief existence.

The Cincinnati Art Pottery Company, Mr. Frank Huntington, president, was organized in 1879, and for several years confined its work to an underglaze faience after the Lambeth style. Later it made Barbotine ware in applied work, but soon dropped this and turned its attention to a more artistic style of overglaze decoration. For a time the "Hungarian faience" was popular with the purchasing public. We are enabled to give an engraving of examples of this (Fig. 31). The latest style of work produced at this factory is called the "Portland blue faience," which consists

of gold and colored decoration on a dark, rich blue ground, of the color of the famous Portland vase. The name *kezonta* has been adopted to designate the wares made here. The origin of the word is interesting. The trade-mark used was the figure of a turtle, and afterward learning that the Indian name for turtle was *kezonta*, the proprietors added this name to the device which

FIG. 31.—"HUNGARIAN FAIENCE." Cincinnati Art Pottery Company.

was employed. Pottery in the biscuit and in blue and white glaze has been sold largely to decorators, the forms being generally modifications of the ancient Roman and Greek. It is with regret we learn that this pottery has been recently closed, the stock of ware on hand having been disposed of by auction.

This, in brief, is the history of the industry which in the past few years has made Cincinnati noted as an art center. In the city Art Museum are about eighty pieces of pottery and porcelain, made between 1875 and 1886, commencing with a small porcelain plate, in blue underglaze decoration, which was painted by Miss McLaughlin in the former year and fired at Greenpoint, Long Island. This collection of early experiments also includes a number of interesting pieces made previous to the establishment of the Rookwood Pottery, by its founder, Mrs. Bellamy Storer, then Mrs. Nicholls.

Some original work of high merit is also being done at the Hampshire Pottery of Messrs. J. S. Taft & Co., Keene, N. H. This pottery was started in 1871 for the manufacture of red ware. Lately the firm has been paying particular attention to art specialties, in new and graceful shapes and novel decorations. The ware is a white, opaque body, covered with a variety of effective glazes. About forty hands are employed, nearly half being decorators. Prof. Edward S. Morse, of Salem, Mass., to whom I am indebted for valuable assistance, first called my attention to these productions.

The Chesapeake Pottery, of Baltimore, Md., was started about

ten years ago by Messrs. D. F. Haynes & Co., and was continued without change until 1887, when the style was altered to The Chesapeake Pottery Company, and again, in 1890, to Haynes, Bennett & Co. Mr. Haynes, who is a practical potter of wide experience and an artist and designer of the highest rank, has invented a number of new bodies and produced a wealth of beautiful designs, which, because of the employment of the printing process in decoration, are to-day beautifying the homes of thousands who could not otherwise enjoy the possession of works of artistic merit. Indeed, the engravings, which have been made especially for these productions, possess so much excellence and are so pleasing in their application to graceful forms that they stand as the exception which proves the rule that the best results can usually be obtained without the aid of mechanical processes. Of the many meritorious designs in high grade dinner sets and the one hundred styles of toilet ware in underglaze printing and overglaze decoration made at this pottery, among the most charming is the Alsatian pattern, made in the new Avalon china body, embellished with the heads of peasants, drawn by Mr. Jesse Shepherd, or scenes from Shakespeare, drawn by Mr. A. Master especially for this set, and printed in vellum tints. The "Merchant of Venice" set is particularly attractive, in which, in a panel on one side, the trial scene is depicted, where Portia says, "The quality of mercy is not strained — it droppeth as the gentle rain from heaven"; and on the other the scene between Antonio, Bassanio, and Shylock, in which the latter exclaims, "And for these courtesies I'll lend you thus much moneys."

FIG. 32.—"MERCHANT OF VENICE" VASE. Chesapeake Pottery.

No less pleasing, though of an entirely different character, is the Arundel ware, which is made entirely from American clays. The body possesses no artificial coloring and is thoroughly vitreous, of a rich olive-brown tint and susceptible of fine finish and delicate relief work. Being made entirely of native materials, it has been named after one of the titles and estates of Lord Balti-

more. This body is made into many useful and decorative shapes, such as jugs, *jardinières*, vases, etc. Pieces of this ware may be seen in Fig. 33. In addition to these productions, the Chesapeake Pottery has turned out ornamental flower-pots, Parian cattle-head plaques in high relief, modeled by Mr. James Priestman, of Boston, from studies of typical animals in the noted herd of Mr. Harvey Adams; also two interesting bas-reliefs representing Winter and Summer, in Parian, the latter modeled by Mr. Priestman and the former by an English artist.

The Clifton ware from this manufactory belongs to the majolica family, and is said to equal, if not surpass, in body the famous Wedgwood ware of the same class.

FIG. 33.—"ARUNDEL" WARE. Chesapeake Pottery.

The ivory ware possesses a body of a soft ivory tint, made from native clays, without the addition of coloring either in body or glaze, whose soft grain and texture render it peculiarly adapted for free treatment and tasteful decoration. Medallions in various colored pastes, on bodies of different tints, which are baked at one firing, have been compared favorably with some of the fine wares made at Etruria, the result of years of intelligent study and experiment in American materials. Many other bodies of equal merit have been invented at this factory, but we have not the space to dwell upon them.

No one of our potters has done so much to beautify the wares for daily use in the household as Mr. Haynes, or accomplished more in the direction of elevating and refining the tastes of the masses, which he considers of even greater importance than the production of a few fine pieces which could only be within the reach of the wealthy. That he has succeeded in this laudable effort is amply demonstrated by the extent to which many of his designs have been copied both at home and abroad.

TILES.—The history of the ceramic art in America would not

be complete without a brief review of the manufacture of ornamental tiles and architectural terra-cotta, which, although extending over only about two decades, furnishes an instance of marvelously rapid development.

As early as 1832, or thereabout, plain fire-brick and tile were made by the American China Manufactory in Philadelphia, then operated by Messrs. Tucker & Hemphill. They advertised these products as being "of a superior quality, manufactured in part from the materials of which the china is composed. These have been proved, by competent judges, to be fully equal to the best Stourbridge brick," which have been celebrated for their excellence for nearly a century and a half. The fire-clays of the Stourbridge district have been used for upward of three hundred years by British manufacturers.

The European exhibits of fancy wall and floor tiles at the Philadelphia Exhibition awakened the American ceramists to a full realization of their insignificance in this broad field, and the majority of ornamental tile works in this country have been established since that great industrial event. With the exception of roofing tiles, Americans made there no exhibit of consequence in this department of the fictile art. As early as 1871 or 1872, however, Messrs. Hyzer & Lewellen, of Philadelphia, had been experimenting in geometrical tiling, and I have before me some interesting examples of these early attempts. Their first experiments were directed to the manufacture of encaustic tiles of geometrical shapes—square, diamond, and triangular—with natural and artificially colored American clays, mainly buff, red, and black, the designs being inlaid to the depth of about a quarter of an inch. While these efforts proved partially successful, the wet clay method employed at that time was unsatisfactory, because the shrinkage was found to be irregular and the pieces came from the kiln of different thicknesses. The next experiments were made by the damp-dust process, which has been employed ever since. The accompanying illustration will show two forms of geomet-

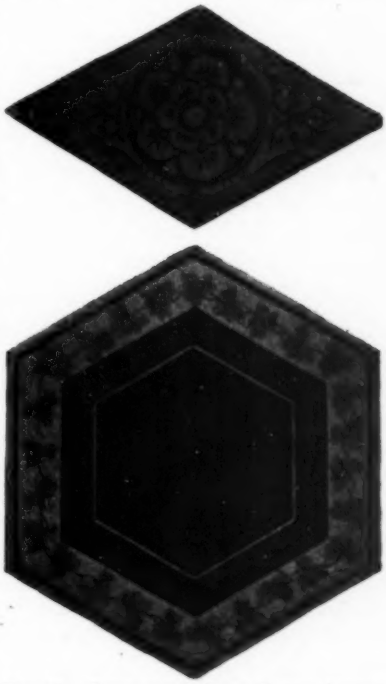

FIG. 34.—SOME OF THE FIRST FANCY AMERICAN TILES. Hyzer and Lewellen.

rical wall tiles which were made previous to 1876. They are plain tiles of yellow clay, of great hardness, the glaze being also hard and entirely free from "crazing," and fully equal to anything of the kind which has since been produced. The hexagonal specimen figured is decorated with painted designs above the glaze, consisting of a green vine on a buff ground, with a red center outlined in black. The lozenge-shaped example is painted with a black device on a lemon ground. Later, several patterns of embossed unglazed mantel tiles, in conventional decoration, were produced, but the manufacture of ornamental tiles was only carried on a short time. At present they make plain geometrical floor tiles of different colored bodies and of exceeding hardness. The clay used is fine and homogeneous, and when burned almost approaches stone-ware. The firm also manufactures fire-brick, dental muffles, and stove-linings.

Furnace tests of the standing-up power of the best-known fire-bricks, instituted by the Second Geological Survey of Pennsylvania in 1876, at Harrisburg, showed that the productions of Messrs. Hyzer & Lewellen were superior, in heat-resisting qualities, to all others that were submitted for examination.

Scarcely two years after the Centennial, Mr. John G. Low, of Chelsea, Mass., who had finished a course of several years in the art schools of Paris, and had recently become interested in the manufacture of pottery, formed a copartnership with his father, Hon. John Low, and immediately commenced the erection of a tile-factory in his native place. Less than a year and a half after the works were started we find the firm competing with English tile-makers at the exhibition at Crewe, near Stoke-on-Trent, which was conducted under the auspices of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society, one of the oldest societies in England. There they won the gold medal, over all the manufacturers of the United Kingdom, for the best collection of art tiles exhibited. This record, probably unsurpassed in ceramic history, serves to illustrate the remarkably rapid development of an industry new in America, but old in the East, and shows the resources at command of the American potter.

In 1883 Hon. John Low retired from the firm, and Mr. John F. Low, son of the founder, became associated with his father, under the style of J. G. & J. F. Low.

Mr. Arthur Osborne, who has designed the majority of the tiles produced here, is a talented artist of the older schools of art, whose conceptions are chaste and classic and possess marked originality.

A novel method was resorted to by Mr. Low in the embellishment of his earlier productions, which he has patented, and which he calls the "natural" process. To secure accurate impressions

of delicate objects, such as grasses, leaves, lace, etc., the article to be represented was placed on the surface of the unburned tile and forced into the clay by means of a press. Such intaglios, plainly showing every small detail of marking, were utilized as molds for forming the raised designs on tiles, which were called "natural tiles."

In the high-relief tiles the undercutting is done by hand after the designs have been stamped in the press. Among Mr. Osborne's designs are ideal heads, mythological subjects, portraits of prominent men, Japanese sketches, and an almost endless variety of animal, bird, and floral studies. His plastic sketches, on a larger scale, are particularly meritorious, some of the most pleasing being a group of sheep in a pasture, a drove of swine, entitled "Late for Dinner," a herd of cows wending their way homeward, and "The Old Windmill." A beautiful conceit is the "Flying Moments," in which three Cupids hover around an hour-glass, one being depicted in the act of winging his way upward (see Fig. 35). These works also make stove tiles, calendar tiles, clothes-hooks, paper-weights, inkstands, and pitchers in plain colors, enameled, and glazed. They at one time also manufactured tile stoves. Lately the Lows have been making a specialty of the manufacture of art-tile soda fountains, in which work Mr. Osborne has found a broader field for the exercise of his talents.

FIG. 35.—A "LOW" TILE, "THE FLYING MOMENTS." By Osborne.

FIG. 36.—PANEL FOR SODA FOUNTAIN. J. G. & J. F. LOW.

The United States Encaustic Tile Works, of Indianapolis, Ind., is the outgrowth of the United States Encaustic Tile Company, which was organized shortly after the Centennial. Five years ago the present proprietors took charge of the works, and are now making encaustic geometrical and relief mantel tiles. So rapidly has the business grown in the past few years that the plant now

includes six bisque and twelve muffle kilns, which are taxed to their utmost capacity. The clays used for white bodies come from South Carolina and Kentucky, and those for dark bodies are obtained from Indiana, the burning being done by means of natural gas. Miss Ruth Winterbotham, who is at present the principal modeler of this factory, has produced many beautiful designs, of which some three and six section panels are probably the most artistic. A series of three mantel panels, representing Dawn, Midday, and Twilight, are particularly deserving of mention, the latter one being shown in the annexed engraving. The method employed in making embossed or relief tiles is that used by all tile works in this country, which was patented by Richard Prosser, in England, in 1840, for making buttons, and shortly after applied by J. M. Blashfield to the manufacture of tiles, called the dust process, which consists in slightly moistening the dry powdered white clay and subjecting it to great pressure in dies containing the designs to be impressed upon them. They are then burned and afterward glazed or enameled in delicate colors. Mr. Robert Minton Taylor, of England, was connected with these works from 1881 to 1883.

FIG. 37. — "TWILIGHT" TILE. United States Encaustic Tile Works. Designed by Miss Winterbotham.

The Beaver Falls Art Tile Company, limited, of Beaver Falls, Pa., was organized in 1886 by Mr. Frank W. Walker, the present secretary and treasurer. These works make a specialty of rectangular and circular stove tiles and manufacture largely fine art relief tiles for wainscoting, hearths, and mantel facings. The present designer is Prof. Isaac Broome, a gentleman of rare artistic ability, a thorough potter, and a sculptor of eminence, who became connected with the works in 1890. In 1878 he was appointed a special commissioner on ceramics at the Paris Exposition and, in conjunction with General McClellan, made a thorough study of the ceramic art as it exists abroad. The varied and extensive knowledge which he has acquired through a life of study has especially fitted him for the work upon which he is now engaged.

After leaving the Ott and Brewer Company he went in 1883 with the Harris Manufacturing Company, now the Trent Tile Company, as modeler, and afterward, in 1886, was instrumental in establishing the Providential Tile Works, of Trenton, N. J., and designed many of their best works. Through his influence the Beaver Falls establishment has made, during the past year and a half, rapid strides in the development of decorative tile manufacture. A complete ceramic color scale has been achieved and a series of glazes produced, of soft, rich tones, a most important result obtained being entire freedom from "crazing," which has already given these works a high reputation Prof. Broome is an indefatigable worker and a prolific artist, his sculptures being characterized by exquisite conception and beautiful execution. While he has produced many more pretentious works, some of his sim-

FIG. 38.—BEAVER FALLS STOVE TILES.

ple designs leave nothing to be desired. One of his most highly admired pieces is a six-inch tile with a Grecian figure (Sappho) leaning on a harp. Prof. Broome has also designed some twelve by twelve inch tiles of great merit which will soon be submitted to the public.

The American Encaustic Tiling Company, of Zanesville, Ohio, is the most extensive establishment of the kind in the United States. It manufactures artistic and encaustic tiles, and has placed upon the market some fine pieces of relief work, twelve by eighteen inches in size, among the subjects of which we have seen some female water-carriers of Grecian type. This factory also

makes an intaglio modeled tile, the effect of which, when filled with glaze, is that of a photograph on a smooth surface of clay. The different depths of the engraving regulate the degree of shading, and portraits of individuals have been executed with great fidelity. It has been mainly through the intelligent management of Mr. George A. Stanbery, the general superintendent, with the assistance of Mr. Karl Langenbeck, the efficient chemist of the company, that such marked success has been achieved. The

FIG. 39.—"SAPPHO." Beaver Falls Art Tile Company. By Broome.

modeling and casting of the dies are the work of Mr. Hermann Mueller, formerly of Coburg, who studied in the Industrial Academy and Preparatory Art School of Nuremberg, and in the Art Academy of Munich. For geometrical designing of encaustic tiles used in flooring and wainscoting the factory employs several competent architects.

The works were projected in 1875 for the manufacture of floor tiles, but in 1880 enameled tiles were added to the products of the factory, and at the present time eleven large kilns are in operation. The city of Zanesville has recently donated a tract of thirty acres to the company, on which an extensive plant is now being erected which will include twenty-eight kilns, to be operated in addition to the present establishment.

The Trent Tile Company, of Trenton, N. J., established about 1882, is now making dull lustered tiles in *alto-relievo*, which process has been patented. This style of finish forms a striking contrast to the glazed and enameled varieties also made here. Effect-

ive panels for mantel facings, six by eighteen inches, in one piece, are also produced. One of these is a center panel in a pastoral facing, which was modeled by Mr. William W. Gallimore, from a sketch in black and white by an artist of the name of Cooper. The scene represents a shepherd boy playing his pipes to his flock.

FIG. 40.—DULL FINISHED TILES. Trent Tile Company.

The peculiar treatment of this piece, in which the sheep in the foreground are in relief and those in the distance in intaglio, is particularly pleasing. Mr. Gallimore, the present modeler for this company, was in his earlier days connected with the Belleek potteries in Ireland, where he lost his right arm by the bursting of a gun. He afterward modeled for Mr. William Henry Goss, at London Road, Stoke-upon-Trent, where, under the supervision of the latter, he produced some admirable Parian busts, including that of the late Mr. Llewellynn Jewitt, which serves as the frontis-

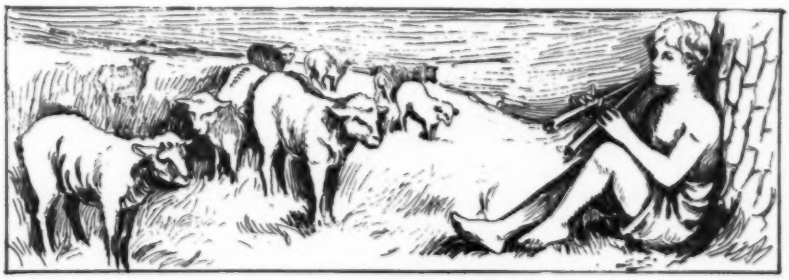

FIG. 41.—PASTORAL PANEL. Trent Tile Company.

piece to the latter's Ceramic Art in Great Britain. Since the loss of his arm, Mr. Gallimore has done his modeling with his left hand, and he has accomplished better work with one arm than he did when in possession of both. He has been with the Trent Company about four years. This company has now six biscuit kilns, and, in addition to the wares made for the general trade, is turning out considerable work of a special nature.

The Providential Tile Works, of Trenton, make glazed tiles, plain and in relief. At one time they experimented in different-colored glazes on the same piece, the raised portions being of a different tint from the ground, and some good results were obtained by this treatment. Underglaze decoration was also employed to

FIG. 42.—TILE PANEL, "INDOLENCE." Providential Tile Works.

some extent formerly, and some fine work in that line was produced, but both of these styles have been abandoned as unsuited to the market. The present designer and modeler is Mr. Scott Callowhill, who came to this country about six years ago from the Royal Worcester Works, England, where, with his brother, Mr. James Callowhill, now of Roslindale, Mass., he had charge of two of the principal decorating-rooms in which the finer class of decoration, in raised paste and gold bronze, was done. He also, while in England, worked for the Doultons, at Lambeth. Some of their newest designs are relief tiles, measuring six by twelve inches, and among their most popular pieces are hunting panels for mantel facings, with such subjects as fighting bucks, stags' heads, sportsmen, and dogs.

One of the most recent applicants for public favor is the Cambridge Art Tile Works, of Covington, Ky., which commenced business in 1887. They are producing high grade enameled and embossed goods of various shapes and in size from one half inch square to six by eighteen inches. The glazes employed are remarkably free from "crazing." The designer and modeler is Mr. Ferdinand Mersman, who studied at the Academy of Fine Arts in Munich. A pair of six by eighteen inch panels, which have just been completed, are examples of exquisite modeling, being copies of Hans Makart's celebrated paintings "Night" and "Morning."

At Anderson, Ind., the Columbia Encaustic Tile Company is

producing inlaid and embossed art tiles, and at other points tile-factories are in operation, but we must content ourselves with this very incomplete sketch of the principal establishments in this country.

In the manufacture of printed, inlaid, and relief tiles, America has advanced rapidly, but in the production of hand-painted art tiles she is sadly deficient. This is a branch of the art that must be developed through the influence of our mechanical art schools, which are paving the way for an early revolution in the ceramic industry in the United States.

FIG. 43.—THE WILKES SCREW TILE PRESS.

Various tile machines have been designed for the manufacture of tiles from dust or semi-dry clay, but we are unable here to reproduce more than one. Fig. 43 shows a screw press, made by Mr. Peter Wilkes, of Trenton, for the Trent Tile Company, and will give an excellent idea of the principle on which the majority of such machines are operated. This forms tiles six inches to twelve inches square, the die being placed between the "push-up" and "plunger." It can also be used for making plates, oval dishes, and other ware.

ARCHITECTURAL TERRA COTTA.—It is interesting to note what the fifth edition of the Encyclopædia Britannica, published in 1815, contains relative to this subject: "Worlidge, and others after him, have endeavored to excite brick-makers to try their skill in making a new kind of brick, or a composition of clay and sand, whereof to form window-frames, chimney-pieces, door-cases, and the like. It is to be made in pieces, fashioned in molds, which, when burnt, may be set together with a fine red cement, and seem as one entire piece. The thing should seem feasible." And so we shall find that it was.

Terra cotta, the most enduring of all building materials, has

been used to a greater or lesser extent from a high antiquity in continental Europe, and in England terra-cotta trimmings were used in building as early as the fifteenth century. In the United States this material does not seem to have been introduced until after 1850. Experiments were made in this direction in 1853 by

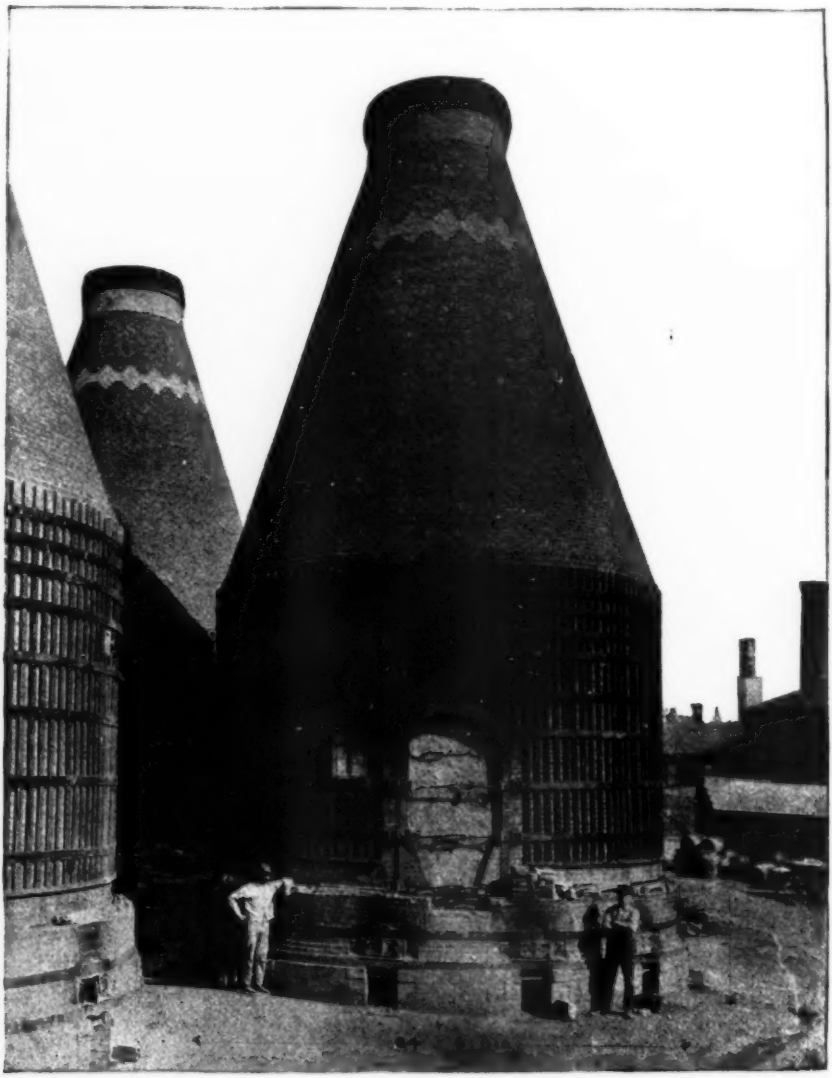

FIG. 44.—THREE KILNS. Perth Amboy Terra Cotta Company.

Mr. James Renwick, a prominent New York architect, but the innovation was not received with favor by builders. In 1870 the Chicago Terra Cotta Company brought over from England Mr. James Taylor, superintendent of the well-known works which

were established by Mr J. M. Blashfield in 1858. By the introduction of the English methods, the Chicago establishment soon turned out better work than had been produced before in the United States.

The Perth Amboy Terra Cotta Company was incorporated in 1879, and at once embarked in the manufacture of large designs for architectural purposes from clay obtained from the neighboring deposits. The plant of this company has expanded so rapidly that at present it includes twenty-two kilns, some of them measuring forty-eight and one third feet in height and twenty-four and one sixth in diameter, which are said to be the largest of the kind on this continent, if not in the world.

FIG. 45.

The company has in its employ a number of eminent artists in this particular line, and has furnished terra-cotta details for many prominent buildings throughout the country. Of these we may mention Young Maennerchor Hall, Philadelphia; Ponce de Leon Hotel, St. Augustine, Florida; Biological Laboratory, Princeton College; and Central School, Ironton, Ohio. Fig. 45 represents a large panel in a warehouse in Jersey City, and Fig. 46 a bas-relief in the St. Anthony Club House, Philadelphia.

Since about 1880 the demand for architectural terra cotta has rapidly increased, and to-day many manufactories are in operation in various parts of the country. In the latter part of 1885 the New York Architectural Terra Cotta Company was organized, and the services of Mr. James Taylor secured as superintendent. The works at Long Island City have furnished designs for more than two thousand buildings, scattered throughout the principal cities of the Union. They have lately succeeded in producing a pure white terra cotta, which is said to be fully equal to the red in durability and hardness, and at present are using this latest invention, in combination with buff bricks, in the rebuilding of Harrigan's Theatre, New York. The effect is novel and pleasing. Other architectural terra-cotta works have also been experimenting recently in the same direction, and it is now only a question of a short time when the more perishable marble, as a building material, will be superseded by this more enduring substitute. Having eliminated the red coloring matter from the composition, it would seem possible, by the introduction of other tints, to produce terra cotta in yellow, blue, or any shade desired. The possibilities in this direction appear almost limitless.

FIG. 46.

FIG. 47.—PANEL IN RESIDENCE OF MR. GEORGE ALFRED TOWNSEND, GAPLAND, ME. New York Architectural Terra Cotta Company.

The Indianapolis Terra Cotta Company, located at Brightwood, Ind., commenced business under its present management in 1886. Mr. Joseph Joiner, a gentleman of large experience in this field, and a highly qualified architect, superintends the manufacturing department.

In the same year Messrs. Stephens & Leach started a factory for architectural terra cotta in West Philadelphia, and later the firm name was changed to Stephens, Armstrong & Conkling.

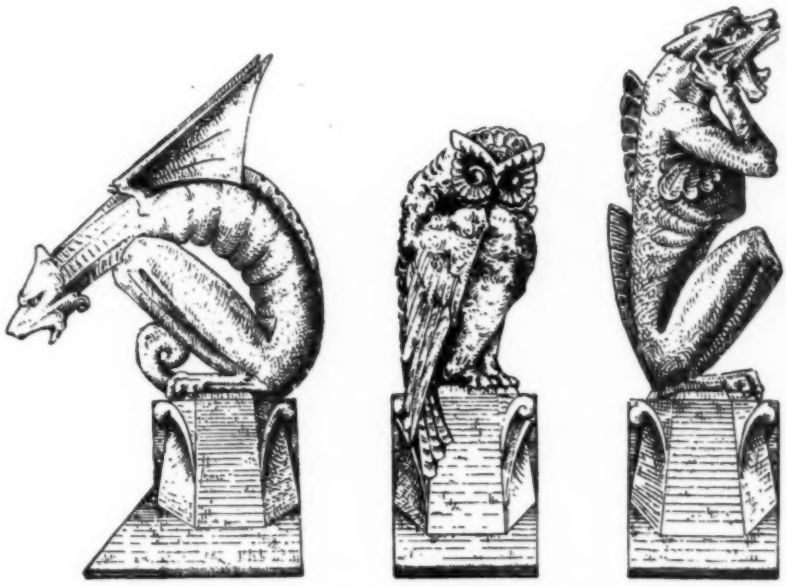

FIG. 48.—FINIALS. Indianapolis Terra Cotta Company.

During the five years of the works' existence it has furnished material for hundreds of important structures in Philadelphia and other cities, of which particular mention may be made of panels and gable work in the library of the University of Pennsylvania, and the Drexel Institute, now being erected in West Philadelphia. A series of animal-head medallions, in high relief, are particularly excellent, and some bas-relief portraits of eminent men, modeled by such sculptors as H. J. Ellicott, John Boyle, and E. N. Conkling, are among their best productions. A medallion of Columbus by Mr. Conkling, and a Cupid and floral panel by Thomas Robertson, are here represented. Admirable work is also being produced by other establishments in Boston, Chicago, and most of our larger cities.

FIG. 49.—MEDALLION OF COLUMBUS.

Recently considerable attention has been given to the construction of brick and tile kilns on scientific principles. Many improved kilns, both on the up-draft and the down-draft systems, have been invented. Art tiles and architectural terra cotta are being burned in up-draft kilns with closed tops, or muffled kilns, in which "saggers," or fire-clay boxes, are used to protect the pieces from direct contact with the flames. Mr. W. A. Eudaly,

FIG. 50.—FLORAL PANEL.

of Cincinnati, has perfected a down-draft kiln which is arranged with compartments in the bottom, which are provided with two separate and distinct sets of flues, one of which carries a portion of the heat into the kiln, and the other conducts a portion from the kiln to stacks or chimneys built in the main wall. The heat is thus divided as it enters the kiln or leaves the furnace, a portion going up through the bags to the ware at the top, while another part surrounds the ware at the bottom of the kiln, securing uniformity of burning and perfect consumption of fuel and

gases. By this method tiles and architectural terra cotta, as well as enamel brick, enameled when green, and thus requiring only one firing, are successfully burned without the use of saggers. Mr. Eudaly also constructs a square down-draft kiln on precisely the same principles, but better adapted to the manufacture of common brick, fire-brick, and sewer-pipe in large quantity, the brick-kilns having a capacity of 80,000 to 300,000, the inside arrangement being such that the heat can be driven to any part of the kiln without altering the fire in the furnace. Thus all the bricks are burned of equal hardness, a vast improvement over the old-fashioned clamp kilns with open tops.

With the failure of natural gas supplies in the West, artificial fuel-gas is destined to become the principal agency in the firing of ceramic products. Its extreme cheapness and perfect adaptability to the needs of the potter will insure its extensive use in the near future. There seems to be no reason to doubt that it will, ere long, supersede wood and coal as a kiln fuel.

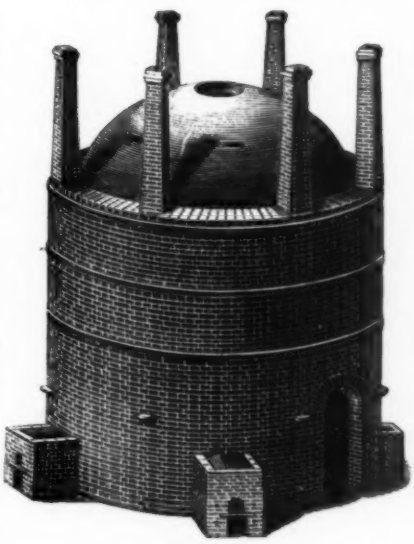

FIG. 51.—THE EUDALY KILN.

At the last convention of the United States Potters' Association, held in Washington in January, 1891, it was decided to open a Pottery School with the co-operation of the Pennsylvania Museum and School of Industrial Art, at Philadelphia, under the efficient management of Prof. L. W. Miller, where designing, modeling, and chemistry shall be taught, and the student fully equipped for usefulness as a practical potter and artist artisan.

American potters have much to learn, but the day is not far distant when, as is the case with other industries, we shall lead the world in this, the oldest and most interesting of the mechanical arts. The Columbian Exposition of 1893 will serve as a powerful impetus toward this end, and the World's Fair Committee appointed by the United States Potters' Association, and composed of such progressive potters as Messrs. J. N. Taylor, Homer Laughlin, J. H. Brewer, James Moses, E. M. Pearson, D. F. Haynes, and C. E. Brockman, will insure a creditable representation of American goods in this branch of the Exhibition.

It is true that American manufacturers have excelled the Eng-

lish in branches of the art which they have seriously undertaken. Our copies of certain European wares are fully equal to the originals, and in some directions are superior. It only requires the proper appreciation and encouragement of the public to furnish the incentive to a broader application of the principles which have been mastered by American artists, in order to produce the best that has been attempted by the older French, Italian, and German schools. In our reproductions of the thin Belleek ware of Ireland, the Limoges faience of the Havilands, and specialties of other Continental factories, we not only equal them, but often excel them, in delicacy of form and beauty of glaze and decoration. Our relief tiles surpass in artistic merit anything produced abroad of a similar character, having won the first premium over British wares long before we brought them to their present state of perfection. Our architectural terra cottas have, within the past few years, left England behind, and, could the absurd prejudice against home art and native work be overcome, America would soon lead the world in ceramic fabrics of every nature. Americans are commencing to discriminate between the meritorious and the meretricious, and to decide in favor of American goods. Having the richest mines in the world, from which the best materials are

FIG. 32.—MILITARY PANEL, G. A. R. MEMORIAL HALL, WILKESBARRE, PA.
New York Architectural Terra Cotta Company.

procured, the most talented artists, and the most highly cultured public, there is no reason why we should not compete with the entire globe in the manufacture of artistic pottery and porcelain. It has been repeatedly stated that our artists are imitative, rather than inventive; but while this may, to a certain extent, be true, and some of our potters have been content to creditably reproduce the well-known wares of foreign schools, others have directed their attention to the perfection of distinctively original products, which, for richness of glazing, excellence of body, and beauty of conception, will rank with the best productions of Europe. The inventive genius of American potters has a vast and practically limitless field for experimenting, and the art schools which have sprung up in our principal cities may in time produce a second Robbia, a worthy successor to Palissy, or an emulator of that prince of potters, Josiah Wedgwood.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIV. THEOLOGY AND POLITICAL ECONOMY.

By ANDREW DICKSON WHITE, LL. D., L. H. D.,
EX-PRESIDENT OF CORNELL UNIVERSITY.

AMONG questions on which the supporters of right reason in political and social science have only conquered theological opposition after centuries of war, is the taking of interest on loans. In hardly any struggle has rigid adherence to the letter of our sacred books been more prolonged and injurious.

Certainly, if the criterion of truth, as regards any doctrine, be that of St. Vincent of Lerins, that it has been believed in the Church "always, everywhere, and by all," then on no point may a Christian of these days be more sure than that every savings institution, every loan and trust company, every bank, every loan of capital by an individual, every means by which accumulated capital has been lawfully lent even at the most moderate interest, to make men workers rather than paupers, is based on deadly sin.

The early evolution of the belief that taking interest for money is sinful presents a curious working-together of metaphysical, theological, and humanitarian ideas.

In the great center of ancient Greek civilization, the loaning of money at interest came to be accepted at an early period as a condition of productive industry, and no legal restriction was imposed. In Rome there was a long process of development. The greed of creditors in early times led to laws against the taking of interest, but, though these lasted long, that strong practical sense, which gave Rome the empire of the world, substituted finally, for this absolute prohibition, the establishment of rates fixed by law. Yet many of the leading Greek and Roman thinkers opposed this practical settlement of the question, and, foremost of all, Aristotle. In a metaphysical way he declared that money is by nature "barren"; that the birth of money from money is therefore "unnatural"; and hence that the taking of interest is to be censured and hated. Plato, Plutarch, both the Catos, Cicero, Seneca, and various other leaders of ancient thought arrived at much the same conclusion—sometimes, from sympathy with oppressed debtors; sometimes, from hatred of usurers; sometimes, from simple contempt of trade.

From these sources there came into the early Church the germ of a theological theory upon the subject.

But far greater was the stream of influence from the Jewish and Christian sacred books. In the Old Testament stood a multitude of texts condemning usury, the term usury meaning any

taking of interest; the law of Moses, while it allowed usury in dealing with strangers, forbade it in dealing with Jews. In the New Testament stood the text in St. Luke, "Lend, hoping for nothing again." These texts seemed to harmonize with the Sermon on the Mount, and with the most beautiful characteristic of primitive Christianity; its tender care for the poor and oppressed: hence we find, from the earliest period, the whole weight of the Church brought to bear against the taking of interest for money.*

The great fathers of the Eastern Church, and among them St. Basil, St. Chrysostom, and St. Gregory of Nyssa; the fathers of the Western Church, and among them Tertullian, St. Ambrose, St. Augustine, and St. Jerome joined most earnestly in this condemnation. St. Basil denounces money at interest as a "fecund monster," and says, "The divine law declares expressly, 'Thou shalt not lend on usury to thy brother or thy neighbor.'" St. Gregory of Nyssa calls down on him who lends money at interest the vengeance of the Almighty. St. Chrysostom says: "What can be more unreasonable than to sow without land, without rain, without plows? All those who give themselves up to this damnable culture shall reap only tares. Let us cut off these monstrous births of gold and silver; let us stop this execrable fecundity." Lactantius called the taking of interest "robbery." St. Ambrose declared it as bad as murder. St. Jerome threw the argument into the form of a dilemma, which was used as a weapon against money-lenders for centuries. St. Anselm proved from the Scriptures that the taking of interest is a breach of the Ten Commandments. Pope Leo the Great solemnly adjudged the same offense to be a sin worthy of severe punishment.†

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* On the general allowance of interest for money in Greece, even at high rates, see Böckh, Public Economy of the Athenians, translated by Lamb, Boston, 1857, especially chaps. xxii, xxiii, and xxiv of Book I. For view of usury taken by Aristotle, see his Politics and Economics, translated by Walford, p. 27; also Grote, History of Greece, vol. iii, chap. xi. For summary of opinions in Greece and Rome, and their relation to Christian thought, see Böhm-Bawerk, Capital and Interest, translated by Smart, London, 1890, chap. i. For a very full list of Scripture texts against the taking of interest, see Pearson, The Theories of Usury in Europe, 1100–1400, Cambridge (England), 1876, p. 6. The texts most frequently cited were: Leviticus, xxv, 36, 37; Deuteronomy, xxiii, 19 and 26; Psalms, xv, 5; Ezekiel, xviii, 8 and 17; St. Luke, vi, 35. For a curious modern use of them, see D. S. Dickinson's speech in the Senate of New York in vol. i of his collected writings. See also Lecky, History of Rationalism in Europe, vol. ii, chap. vi; and, above all, as the most recent historical summary by a leading historian of political economy, Böhm-Bawerk as above.

† For St. Basil and St. Gregory of Nyssa, see French translation of these diatribes in Homélies contre les Usuriers, Paris, Hachette, 1861–'62, especially p. 30 of St. Basil. For some doubtful reservations by St. Augustine, see Murray, History of Usury. For St. Ambrose, see the De Officiis, lib. iii, cap. ii, in Migne, Patrologia, tome xvi; also the De Tobia, in Migne, tome xiv. For St. Augustine, see De Bapt. contra Donat, lib. iv, cap.

This unanimity of the fathers of the Church brought about a crystallization of hostility to interest-bearing loans into numberless decrees of popes and councils and kings and legislatures throughout Christendom during more than fifteen hundred years; and the canon law was shaped in accordance with these. At first these were more especially directed against the clergy, but we soon find them extending to the laity. These prohibitions were enforced by the Council of Arles in 314, and a modern church apologist insists that every great assembly of the Church, from the Council of Elvira in 306 to that of Vienne in 1311, inclusive, solemnly condemned lending money at interest. The greatest rulers under the sway of the Church—Justinian, in the Empire of the East; Charlemagne, in the Empire of the West; Alfred, in England; St. Louis, in France—yielded fully to this dogma. In the ninth century Alfred went so far as to confiscate the estates of money-lenders, denying them burial in consecrated ground; and similar decrees were made in other parts of Europe. In the twelfth century the Greek Church seems to have relaxed its strictness somewhat, but the Roman Church grew more severe. Peter Lombard, in his Sentences, a great source of orthodox theology, makes the taking of interest purely and simply theft. St. Bernard, reviving religious earnestness in the Church, took the same view. In 1179 the Third Council of the Lateran decreed that impenitent money-lenders should be excluded from the altar, from absolution in the hour of death, and from Christian burial. Pope Urban III reiterated the declaration that the passage in St. Luke forbade the taking of any interest whatever. Pope Alexander III declared that the prohibition in this matter could never be suspended by dispensation.

In the thirteenth century Pope Gregory IX dealt an especially severe blow at commerce by his declaration that even to advance on interest the money necessary in maritime trade was damnable usury. This idea was still more firmly fastened upon the world by the two greatest thinkers of the time: first, by St. Thomas Aquinas, who knit it into the mind of the Church by the use of the Scriptures and of Aristotle; and next by Dante, who pictured money-lenders in one of the worst parts of hell.

At the beginning of the fourteenth century the Council of

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ix, in Migne, tome xliii. For Lactantius, see Lact., Opera, Leyden, 1660, p. 608. For Cyprian, see his Testimonies against the Jews, translated by Wallis, Book III, article 48. For St. Jerome, see his Com. in Ezekiel, xviii, 8, in Migne, tome xxv, pp. 170 *et seq.* For Leo the Great, see his Letter to the Bishops of various provinces of Italy, cited in Jus Can., cap. vii, can. xiv, qu. 4. For very fair statements of the attitude of the fathers on this question, see Addis and Arnold, Catholic Dictionary, London, 1884, and Smith and Cheetham, Dictionary of Christian Antiquities, Hartford, 1880, in each under article Usury.

Vienne, presided over by Pope Clement V, declared that if any one "shall pertinaciously presume to affirm that the taking of interest for money is not a sin, we decree him to be a heretic, fit for punishment." This infallible utterance bound the dogma with additional force on the conscience of the universal Church.

Nor was this a doctrine enforced only by rulers; the people were no less strenuous. In 1390 it was enacted by the city authorities of London that "if any person shall lend or put into the hands of any person gold or silver to receive gain thereby, such person shall have the punishment for usurers." And in the same year the Commons prayed the king that the laws of London against usury might have the force of statutes throughout the realm.

In the fifteenth century the Council of the Church at Salzburg excluded from communion and burial any who took interest for money, and this was a very general rule throughout Germany.

An exception was, indeed, sometimes made: some canonists held that Jews might be allowed to take interest, since they were to be damned in any case, and their monopoly of money-lending might prevent Christians from losing their souls by going into the business. Yet even the Jews were from time to time punished for the crime of usury, and, both as regards Jews and Christians, punishment was bestowed on the dead as well as the living; the bodies of dead money-lenders being here and there dug up and cast out of consecrated ground.

The popular preachers constantly declaimed against all who took interest. The mediæval anecdote books for pulpit use are especially full on this point. Jacques de Vitry tells us that demons on one occasion filled a dead money-lender's mouth with red-hot coins; Cæsar, of Heisterbacho, declared that a toad was found thrusting a piece of money into a dead usurer's heart; in another case, a devil was seen pouring molten gold down a dead money-lender's throat.*

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* For an enumeration of councils condemning the taking of interest for money, see Liégois, Essai sur l'histoire et la législation de l'usure, Paris, 1865, p. 78; also the Catholic Dictionary as above. For curious additional details and sources regarding mediæval horror of usurers, see Ducange, Glossarium, etc., article Caorcini. The date, 306, for the Council of Elvira is that assigned by Hefele. For the decree of Alexander III, see citation from the Latin text in Lecky. For a long catalogue of ecclesiastical and civil decrees against taking of interest, see Petit, Traité de l'Usure, Paris, 1840. For the reasoning at bottom of this, see Cunningham, Christian Opinion upon Usury, London, 1884. For the Salzburg decrees, see Zillner, Salzburgische Culturgeschichte, p. 232; and for Germany generally, see Neumann, Geschichte des Wuchers im Deutschland, Halle, 1865, especially p. 22 *et seq.*; also Roscher, National Oeconomic. For effect of mistranslation of the passage of Luke in the Vulgate, see Döllinger, p. 170, and especially pp. 224, 225. For the capitularies of Charlemagne against usury, see Liégois, p. 77. For Peter Lombard, see his Lib. Sententiarum, lib. iii, dist. XXXVII, 3. For St. Thomas Aquinas, see his works, Migne, vol.

This theological hostility to the taking of interest was imbedded firmly in the canon law. Again and again it defined usury to be the taking of anything of value beyond the exact original amount of a loan; and under sanction of the universal Church it denounced this as a crime and declared all persons defending it to be guilty of heresy. What this meant the world knows but too well.

The whole evolution of European civilization was greatly hindered by this conscientious policy. Money could only be loaned in most countries at the risk of incurring odium in this world and damnation in the next; hence there was but little capital and few lenders. The rates of interest became at times enormous; as high as forty per cent in England, and ten per cent a month in Italy and Spain. Commerce, manufactures, and general enterprise were dwarfed, while pauperism flourished.

Yet worse than these were the moral results. Doing what one believes is evil is only second in bad consequences to doing what is really evil; hence, all lending and borrowing, even for the most legitimate purposes and at the most reasonable rates, tended to debase the character of both borrower and lender. The prohibition of interest for the use of money in continental Europe promoted luxury and discouraged economy, the rich, who were not engaged in business, finding no easy way of employing their savings productively.

One evil effect is felt in all parts of the world to this hour. The Jews, so strong in will and acute in intellect, were virtually drawn or driven out of all other industries or professions by the theory that their race, being accursed, was only fitted for the accursed profession of money-lending.*

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iii, Paris, 1889, question 78, pp. 586 *et seq.*, citing the Scriptures and Aristotle, and especially developing Aristotle's metaphysical idea regarding the "barrenness" of money. For a very good summary of St. Thomas's ideas, see Pearson, pp. 30 *et seq.* For Dante, see in Canto XI of the Inferno a revelation of the amazing depth of the hostility to the taking of interest. For the London law of 1390 and the petition to the king, see Cunningham, Growth of English Industry and Commerce, pp. 210 and 326; also the Abridgment of the Records in the Tower of London, p. 339. For the theory that Jews, being damned already, might be allowed to practice usury, see Liégois, Histoire de l'Usure, p. 82. For St. Bernard's view, see Epist. CCCLXIII, in Migne, tome clxxxii, p. 567. For ideas and anecdotes for preachers' use, see Joannes de San Geminiano, Summa de Exemplis, Antwerp, 1629, fol. 493, *a*; also an edition of Venice, 1584, pp. 132 and 159; but especially for multitudes of examples, see the Exempla of Jacques de Vitry, edited by Prof. T. F. Crane, of Cornell University, London, 1890, pp. 203 *et seq.* For the canon law in relation to usance, see a long line of authorities cited in Die Wucherfrage, St. Louis, 1869, pp. 92 *et seq.*, and especially Decret. Gregor., lib. v, lit. 19, cap. iii, and Clementin, lib. v, lit. 5, sec. 2; see also the Corpus Juris Canonici, Paris, 1618, pp. 227, 228. For the position of the English Church, see Gibson's Corpus Juris Ecclesiastici Anglicani, pp. 1070, 1071, and 1106.

* For evil economic results, and especially for the rise of the rate of interest in England and elsewhere at times to forty per cent, see Cunningham, Growth of English Industry and Commerce, Cambridge, 1890, p. 189; and for its rising to ten per cent a month,

These evils seemed so manifest, when trade began to revive throughout Europe in the fifteenth century, that most earnest exertions were put forth to induce the Church to change its position.

The first important effort of this kind was made by John Gerson. His general learning made him Chancellor of the University of Paris; his sacred learning made him the leading orator at the Council of Constance; his piety led men to attribute to him The Imitation of Christ. Shaking off theological shackles, he declared: "Better is it to lend money at reasonable interest, and thus to give aid to the poor, than to see them reduced by poverty to steal, waste their goods, and sell at a low price their personal and real property."

But this idea was at once buried beneath citations from the Scriptures, from the fathers, councils, popes, and the canon law. Even in the most active countries there seemed to be no hope. In England, under Henry VII, Cardinal Morton, the lord chancellor, addressed Parliament, asking it to take into consideration loans of money at interest. The result was a law which imposed on lenders at interest a fine of a hundred pounds besides the annulment of the loan; and, to show that there was an offense against religion involved, there was added a clause "reserving to the Church, notwithstanding this punishment, the correction of their souls according to the laws of the same."

Similar enactments were made by civil authority in various parts of Europe; and just when the trade, commerce, and manufactures of the modern epoch had received an immense impulse from the great series of voyages of discovery by such men as Columbus, Vasco da Gama, Magellan, and the Cabots, this barrier against enterprise was strengthened by a decree from no less enlightened a pontiff than Leo X.

The popular feeling warranted such decrees. As late as the end of the middle ages, we find the people of Piacenza dragging the body of a money-lender out of his grave in consecrated ground and throwing it into the Po, in order to stop a prolonged rain-storm; and outbreaks of the same spirit are frequent in other countries.*

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see Bédarride, Les Juifs en France, en Italie et en Espagne, p. 220. See also Hallam's Middle Ages, London, 1853, pp. 401, 402. For the evil moral effects of the Church doctrine against taking interest, see Montesquieu, Esprit des Lois, lib. xxi, chap. xx. See also Sismondi, cited in Lecky. For the trifling with conscience, distinction between "consumptibles" and "fungibles," "possessio" and "dominium," etc., see Ashley, English Economic History, New York, 1888, pp. 152, 153. For effects of these doctrines on the Jews, see Milman, History of the Jews, vol. iii, p. 179; also Wellhausen, History of Israel, London, 1885, p. 546; also Beugnot, Les Juifs d'Occident, Paris, 1824, B, p. 114 (on driving Jews out of other industries than money-lending).

* For Gerson's argument favoring a reasonable rate of interest, see Coquelin and Guil-

Another mode of obtaining relief was tried. Subtle theologians devised evasions of various sorts. Two among these inventions of the schoolmen obtained much notoriety.

The first was the doctrine of "*damnum emergens*": if a man, in order to loan money, was obliged to withdraw it from profitable business, and so suffer loss, it was claimed that he might demand of the borrower compensation for such loss. Equally cogent was the doctrine of "*lucrum cessans*": if a man, in order to loan money, was obliged to diminish his income from productive enterprises, it was claimed that he might receive in return, in addition to his money, an amount exactly equal to this diminution in his income.

But such evasions were looked upon with little favor by the great body of theologians, and the name of St. Thomas Aquinas was cited against them.

Opposition on scriptural grounds to the taking of interest was not confined to the older Church. Protestantism was led by Luther and several of his associates into the same line of thought and practice. Said Luther: "To exchange anything with any one and gain by the exchange is not to do a charity, but to steal. Every usurer is a thief worthy of the gibbet. I call those usurers who lend money at five or six per cent." But it is only just to say that at a later period Luther took a much more moderate view. Melanchthon, defining usury as any interest whatever, condemned it again and again; and the Goldberg Catechism of 1558, for which he wrote a preface and recommendation, declares every person taking interest for money a thief; from generation to generation this doctrine was upheld by the more eminent divines of the Lutheran Church in all parts of Germany.

The English reformers showed the same hostility to interest-bearing loans. Under Henry VIII the law of Henry VII against taking interest had been modified for the better; but the revival of religious feeling under Edward VI caused in 1552 the passage

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laumin, Dictionnaire, article Intérêt. For the renewed opposition to the taking of interest in England, see Craik, History of British Commerce, chap. vi. The statute cited is 3 Henry VII, chap. vi. It is found in Gibson's Corpus Juris Eccles. Anglic., p. 1071. For the adverse decree of Leo X, see Liégois, p. 76. See also Lecky, Rationalism, vol. ii. For the dragging out of the usurer's body at Piacenza, see Burckhardt, The Renaissance in Italy, London, 1878, vol. ii, p. 339. For public opinion of similar strength on this subject in England, see Cunningham, p. 239; also Pike, History of Crime in England, vol. i, pp. 127, 193. For good general observations on the same, see Stephen, History of Criminal Law in England, London, 1883, vol. iii, pp. 195–197. For usury laws in Castile and Aragon, see Bédarride, pp. 191, 192. For exceedingly valuable details as to the attitude of the mediæval Church, see Léopold Delisle, Études sur la Classe Agricole en Normandie au Moyen Âge, Evreux, 1851, pp. 200 *et seq.*, also p. 468. For penalties in France, see Matthew Paris, Chronica Majora, in Master of the Rolls series, especially vol. iii, pp. 191, 192.

of the "Bill of Usury." In this it is said, "Forasmuch as usury is by the word of God utterly prohibited, as a vice most odious and detestable, as in divers places of the Holy Scriptures it is evident to be seen, which thing by no godly teachings and persuasions can sink into the hearts of divers greedy, uncharitable, and covetous persons of this realm, nor yet, by any terrible threatenings of God's wrath and vengeance," etc., it is enacted that whosoever shall thereafter lend money "for any manner of usury, increase, lucre, gain, or interest, to be had, received, or hoped for," shall forfeit principal and interest, and suffer imprisonment and fine at the king's pleasure.*

But, most fortunately, it happened that Calvin, though at times stumbling over the usual texts against the usance of money, turned finally in the right direction. He cut through the metaphysical arguments of Aristotle, and characterized the mass of subtleties devised to evade the Scriptures as "a childish game with God." In place of these subtleties, there was developed among Protestants a serviceable fiction—the statement that usury means *illegal or oppressive interest*. Under the action of this fiction, commerce and trade revived rapidly in Protestant countries, though with occasional checks from exact interpreters of Scripture. At the same period in France, the great Protestant jurist, Dumoulin, brought all his legal learning and skill in casuistry to bear on the same side. A certain ferret-like acuteness and litheness seem to have enabled him to hunt down the opponents of usance through the most tortuous arguments of scholasticism.

In England the struggle went on with varying fortune; statesmen on one side, and theologians on the other. We have seen how under Henry VIII interest was allowed at a fixed rate, and how the development of English Protestantism having at first strengthened the old theological view, there was, under Edward VI, a temporarily successful attempt to forbid usance by law. The Puritans, dwelling on Old Testament texts, continued for a considerable time especially hostile to the taking of any interest. Henry Smith, a noted preacher, thundered from the pulpit of St. Clement Danes in London against "the evasions of Scripture" which permitted men to loan money on interest at all. In answer to the contention that only "biting" usury was oppress-

* For Luther's views see his sermon, Von dem Wucher, Wittenberg, 1519, also the Tischreden, cited in Coquelin and Guillaumin, article Intérêt. For the later more moderate views of Luther, Melanchthon, and Zwingli, making a compromise with the needs of society, see Böhm-Bawerk, p. 27, citing Wiskemann. For Melanchthon and a long line of the most eminent Lutheran divines who have denounced the taking of interest, see Die Wucherfrage, St. Louis, 1869, pp. 94 *et seq.* For the law against usury under Edward VI, see Cobbett's Parliamentary History, vol. i, p. 596; see also Craik, History of British Commerce, chap. vi.

ive, Wilson, a noted upholder of the strict theological view in political economy, declared: "There is difference in deed between the bite of a dogge and the bite of a flea, and yet, though the flea doth lesse harm, yet the flea doth bite after hir kinde, yea, and draweth blood, too. But what a world this is, that men will make sin to be but a flea-bite, when they see God's word directly against them."

The same view found strong upholders among contemporary English Catholics. One of the most eminent of these, Nicholas Sanders, revived very vigorously the use of an old scholastic argument. He insisted that "man can not sell time," that time is not a human possession, but something which is given by God alone: he declared, "Time was not of your gift to your neighbor, but of God's gift to you both."

In the Parliament of the period, we find strong assertions of the old idea, with constant reference to Scripture and the fathers. In one debate, Wilson cited from Ezekiel and other prophets and attributed to St. Augustine the doctrine that "to take but a cup of wine is usury and damnable." Fleetwood recalled the law of King Edward the Confessor, which submitted usurers to the ordeal.

But arguments of this sort had little influence upon Elizabeth and her statesmen. They re-established the practice of the taking of interest under restrictions, and this, in various forms, has remained in England ever since Most notable in this phase of the evolution of scientific doctrine in political economy at that period is the emergence from the political chaos of a recognized difference between *usury* and *interest*. Between these two words, which had so long been synonymous, a distinction now appears: the former being construed to indicate oppressive interest, and the latter just rates for the use of money. This idea gradually sank into the popular mind of Protestant countries, and the scriptural texts no longer presented any difficulty to the people at large, since there grew up a general belief that the word "usury," as used in Scripture, had always meant exorbitant interest. Still, that the old Aristotelian quibble had not been entirely forgotten, is clearly seen by various passages in Shakespeare's Merchant of Venice. But this line of reasoning seems to have received its quietus from Lord Bacon. He did not indeed develop a strong and connected argument on the subject, but he burst the bonds of Aristotle, and based usance for money upon natural laws. How powerful the new current of thought was, is seen from the fact that James I, of all monarchs the most fettered by scholasticism and theology, sanctioned a statute dealing with interest for money as absolutely necessary. Yet, even after this, the old idea asserted itself, for the bishops utterly refused to agree

to the law allowing interest until a proviso was inserted that "nothing in this law contained shall be construed or expounded to allow the practice of usury in point of religion or conscience." The old view cropped out from time to time in various public declarations. Among these was the book of John Blaxton, an English clergyman, who in 1634 published his Usury Condemned. In this, he defines usury as the taking of any interest whatever for money, citing in support of this view six archbishops and bishops and over thirty doctors of divinity in the Anglican Church—some of their utterances being very violent and all of them running their roots down into texts of Scripture. Typical among these is a sermon of Bishop Sands, in which he declares, regarding the habit of taking interest: "This canker that hath corrupted all England; we shall doe God and our country true service by taking away this evill; represse it by law, else the heavy hand of God hangeth over us and will strike us."

But departures from the strict scriptural doctrines regarding interest soon became frequent in Protestant countries. They appear to have been first followed up with vigor in Holland. Various theologians in the Dutch Church attempted to assert the scriptural view by excluding bankers from the holy communion, but the commercial vigor of the republic was too strong: Salmasius led on the forces of right reasoning brilliantly and by the middle of the seventeenth century the question was settled rightly in that country. This work was aided, indeed, by a far greater man—Hugo Grotius; but here was shown the power of an established dogma. Great as Grotius was—and though it may well be held that his book on War and Peace has wrought more benefit to humanity than any other attributed to human authorship—he was, in the matter of usance for money, too much entangled in theological reasoning to do justice to his cause or to himself. He declared the prohibition of interest to be scriptural, but resisted the doctrine of Aristotle, and allowed usance on certain natural and practical grounds.

In Germany the struggle lasted longer. Of some little significance, perhaps, is the demand of Adam Contzen, in 1629, that lenders at interest should be punished as thieves; but by the end of the seventeenth century Puffendorf and Leibnitz had gained the victory.

Protestantism, open as it was to the currents of modern thought, could not long continue under the dominion of ideas unfavorable to economic development, and perhaps the most remarkable example of this was presented early in the eighteenth century by no less strict a theologian than Cotton Mather. In his Magnalia he argues against the whole theological view with a boldness, acute-

ness, and good sense which cause us to wonder that this can be the same man who was so infatuated regarding witchcraft. After an argument so conclusive as his, there could have been little left of the old anti-economic doctrine in New England.*

But while the retreat in the Protestant Church was henceforth easy, in the Catholic Church it was far more difficult. Infallible popes and councils, saints, fathers, and doctors, had so constantly declared the taking of any interest at all to be contrary to Scripture, that the more exact though less fortunate interpretation of the sacred text relating to interest continued in Catholic countries. When it was attempted in France in the seventeenth century to argue that usury "means oppressive interest," the Theological Faculty of the Sorbonne declared that usury is the taking of any interest at all, no matter how little, and the eighteenth chapter of Ezekiel was cited to clinch this argument.

Another attempt to ease the burden of industry and commerce was made by declaring that "usury means interest demanded not as a matter of favor, but as a matter of right." This, too, was solemnly condemned by Pope Innocent XI.

Again, an attempt was made to find a way out of the difficulty by declaring that "usury is interest greater than the law allows." This, too, was condemned, and so also was the declaration that "usury is interest on loans not for a fixed time."

Still, the forces of right reason pressed on, and, among them, in the seventeenth century, in France, was Richard Simon. He attempted to gloss over the declarations of Scripture against usance in an elaborate treatise, but was immediately confronted by Bossuet, the greatest of French bishops, one of the keenest and strongest of thinkers. Just as Bossuet had mingled Script-

* For Calvin's views, see his letter published in the appendix to Pearson's Theories on Usury. His position is well stated in Böhm-Bawerk, pp. 28 *et seq.*, where citations are given. See also Economic Tracts, No. IV, New York, 1881, pp. 34, 35; and for some serviceable Protestant fictions, see Cunningham, Christian Opinion on Usury, pp. 60, 61. For Dumoulin (Molinæus), see Böhm-Bawerk, as above, pp. 29 *et seq.* For debates on usury in British Parliament in Elizabeth's time, see Cobbett, Parliamentary History, vol. i, pp. 756 *et seq.* The passage in Shakespeare is in the Merchant of Venice, Act I, Scene III: "If thou wilt lend this money, lend it not as to thy friend; for when did friendship take a breed for barren metal from his friend?" For the right direction taken by Lord Bacon, see Neumann, Geschichte des Wuchers in Deutschland, Halle, 1865, pp. 497, 498. For Grotius, see the De Jure Belli ac Pacis, lib. ii, cap. xii; and for Salmasius and others mentioned, see Böhm-Bawerk, pp. 34 *et seq.*, also Lecky, vol. ii, p. 256. For the saving clause inserted by the bishops in the statute of James I, see the Corpus Juris Eccles. Anglic., p. 1071; also Murray, History of Usury, Philadelphia, 1866, p. 49. For Blaxton, see his English Usurer; or, Usury Condemned, by John Blaxton, Preacher of God's Word, London, 1634. Blaxton gives some of Calvin's earlier utterances against interest. For Bishop Sands's sermon, see p. 11. For Cotton Mather's argument, see the Magnalia, London, 1702, pp. 51, 52.

ure with astronomy and opposed the Copernican theory, so now he mingled Scripture with political economy and denounced the lending of money at interest. He called attention to the fact that the Scriptures, the councils of the Church from the beginning, the popes, the fathers, had all interpreted the prohibition of "usury" to be a prohibition of any lending at interest; and he demonstrated this interpretation to be the true one. Simon was put to confusion and his book condemned.

There was but too much reason for Bossuet's interpretation. There stood the fact that the prohibition of one of the most simple and beneficial principles in political and economical science was affirmed, not only by the fathers, but by twenty-eight councils of the Church, six of them general councils, and by seventeen popes, to say nothing of innumerable doctors in theology and canon law. And these prohibitions by the Church had been accepted as of divine origin by all obedient sons of the Church in the Government of France. Such rulers as Charles the Bald in the ninth century, and St. Louis in the thirteenth, had riveted this idea into the civil law so firmly that it seemed impossible ever to detach it.*

As might well be expected, Italy was one of the countries in which the theological theory regarding usance was most generally asserted and assented to. Among the great number of Italian canonists who supported the theory, two deserve especial mention, as affording a contrast to the practical manner in which the commercial Italians met the question.

In the sixteenth century, very famous among canonists was the learned Benedictine, Vilagut. In 1589 he published at Venice his great work on usury, supporting with much learning and vigor the most extreme theological consequences of the old doctrine. He defines usury as the taking of anything beyond the original loan, and declares it mortal sin; he advocates the denial to usurers of Christian burial, confession, the sacraments, absolution, and connection with the universities; he declares that priests receiving offerings from usurers should refrain from exercising their ministry until the matter is passed upon by the bishop.

About the middle of the seventeenth century another ponder-

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* For the declaration of the Sorbonne in the seventeenth century against any taking of interest, see Lecky, Rationalism, vol. ii, p. 248, note. For the special condemnation by Innocent XI, see Damnatæ Theses, Pavia, 1715, pp. 112–114. For consideration of various ways of escaping the difficulty regarding interest, see Lecky, Rationalism, vol. ii, pp. 249, 250. For Bossuet's strong declaration against taking interest, see Œuvres de Bossuet, edition of 1845, vol. xi, p. 330, and edition of 1846, vol. ix, p. 49 *et seq.* For the number of councils and popes who condemned usury, see Lecky, Rationalism, vol. ii, p. 255, note, citing Concina.

ous folio was published in Venice upon the same subject and with the same title, by Onorato Leotardo. So far from showing any signs of yielding, he is even more extreme than Vilagut had been, and quotes with approval the old declaration that lenders of money at interest are not only robbers but murderers.

So far as we can learn, no real opposition was made in either century to this theory, as a theory; as to *practice*, it was different. The Italian bankers and traders did not answer the theological argument; they simply overrode it. Nowhere was commerce carried on in more complete defiance of this and other theological theories hampering trade than in the very city where these great treatises were published. The sin of usury, like the sin of commerce with the Mohammedans, seems to have been settled for by the Venetian merchants on their death-beds, and greatly to the advantage of the magnificent churches and ecclesiastical adornments of the city.

But in the eighteenth century there came a change. The first effective onset of political scientists against the theological opposition in southern Europe was made in Italy; the most noted leaders in the attack being Galiani and Maffei.

Here and there feeble efforts were made to meet them, but it was felt more and more by thinking churchmen that entirely different tactics must be adopted.

About the same time came an attack in France, and, though its results were less immediate at home, they were much more effective abroad. In 1748 appeared Montesquieu's Spirit of the Laws. In this famous book were concentrated twenty years of study and thought by a great thinker on the interests of the world about him. In eighteen months it went through twenty-two editions; it was translated into every civilized language; and among the things on which Montesquieu brought his wit and wisdom to bear with especial force was the doctrine of the Church regarding interest on loans. In doing this he was obliged to use a caution in forms which seems strangely at variance with the boldness of his ideas. In view of the strictness of ecclesiastical control in France, he felt it safest to make his whole attack upon those theological and economic follies of Mohammedan countries which were similar to those which the theological spirit had fastened on France.*

By the middle of the eighteenth century the Church authorities at Rome clearly saw the necessity of a concession: the world would endure theological restriction no longer; a way of escape

* For Vilagut, see his Tractatus de Usuris, Venice, 1589, especially pp. 21, 25, and 399. For Leotardus, see his De Usuris, Venice, 1655, especially preface, pp. 6, 7 *et seq.* For the eighteenth century attack in Italy, see Böhm-Bawerk, pp. 48 *et seq.* For Montesquieu's view of interest on loans, see the Esprit des Lois.

must be found. It was seen even by the most devoted theologians that mere denunciations and use of theological arguments or scriptural texts against the scientific idea were futile.

To this feeling it was due that, even in the first years of the century, the Jesuit casuists had come to the rescue. With exquisite subtlety some of their acutest intellects devoted themseves to explaining away the utterances on this subject of saints, fathers, doctors, popes, and councils. These explanations were wonderfully ingenious, but many of the older churchmen continued to insist upon the orthodox view, and at last the Pope himself intervened. Fortunately for the world, the seat of St. Peter was then occupied by Benedict XIV, certainly one of the most gifted, morally and intellectually, in the whole line of Roman pontiffs: tolerant and sympathetic for the oppressed, he saw the necessity of taking up the question, and he grappled with it effectually. While severe against exorbitant usury, he rendered to Catholicism a service like that which Calvin had rendered to Protestantism, by quietly but vigorously cutting a way through the theological barrier. In 1745 he issued his encyclical, *Vix pervenit*, which declared that the doctrine of the Church remained consistent with itself; that usury is indeed a sin, and that it consists in *demanding any amount beyond the exact amount lent*, but that there are occasions when on special grounds the lender may obtain such additional sum.

What these "occasions" and "special grounds" might be, was left very vague; but this action was sufficient.

At the same time no new restrictions upon books advocating the taking of interest for money were imposed, and the Pope openly accepted the dedication of one of them.

Like the casuistry of Boscovich in using the Copernican theory for "convenience in argument," while acquiescing in its condemnation by the Church authorities, this encyclical of Pope Benedict broke the spell. Turgot, Quesnay, Adam Smith, Hume, Bentham, and their disciples pressed on, and science won for mankind another great victory.*

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* For Quesnay, see his Observations sur l'Intérêt de l'Argent, in his Œuvres, Frankfort and Paris, 1888, pp. 399 *et seq.* For Turgot, see the Collection des Économistes, Paris, 1844, vols. iii and iv; also, Blanqui, Histoire de l'Économie Politique, English translation, p. 373. For an excellent though brief summary of the efforts of the Jesuits to explain away the old action of the Church, see Lecky, vol. ii, pp. 256, 257. For the action of Benedict XIV, see Reusch, Der Index der Verbotener Bücher, Bonn, 1885, vol. ii, pp. 847, 848. For a comical picture of the "quagmire" into which the hierarchy brought itself in the squaring of its practice with its theory, see Döllinger as above, pp. 227, 228. For cunningly vague statements of the action of Benedict XIV, see Mastrofini, Sur l'Usure, French translation, Lyons, 1834, pp. 125 and 255. The abbé, as will be seen, has not the slightest hesitation in telling an untruth, in order to preserve the consistency of papal action in the matter of usury; e. g., pp. 93, 94, 96, and elsewhere.

Yet in this case, as in others, insurrections against the sway of scientific truth appeared among some overzealous religionists. When the Sorbonne, having retreated from its old position, armed itself with new casuistries against those who held to its earlier decisions, sundry provincial doctors in theology protested indignantly, making the old citations from the Scriptures, fathers, saints, doctors, popes, councils, and canonists. Again the Roman court intervened. In 1830 the Inquisition at Rome, with the approval of Pius VIII, though still declining to commit itself on the *doctrine* involved, decreed that, as to *practice*, confessors should no longer disturb lenders of money at legal interest.

But even this did not quiet the more conscientious theologians. The old weapons were again furbished and hurled by the Abbé Laborde, Vicar of the Metropolitan Archdiocese of Auch, and by the Abbé Dennavit, Professor of Theology at Lyons. Good Abbé Dennavit declared that he refused absolution to those who took interest and to priests who pretend that the sanction of the civil law is sufficient.

But the "wisdom of the serpent" was again brought into requisition, and early in the decade between 1830 and 1840 the Abbate Mastrofini issued a work on usury, which, he declared on its title-page, demonstrated that "moderate usury is not contrary to Holy Scripture, or natural law, or the decisions of the Church." Nothing can be more comical than the suppressions of truth, evasions of facts, jugglery with phrases, and perversions of history, to which the good abbate is forced to resort throughout his book in order to prove that the Church has made no mistake. In the face of scores of explicit deliverances and decrees of fathers, doctors, popes, and councils, against the taking of any interest whatever for money, he coolly pretended that what they had declared against was *exorbitant* interest. He made a merit of the action of the Church, and showed that its course had been a blessing to humanity. But his masterpiece is in dealing with the edicts of Clement V and Benedict XIV. As to the first, it will be remembered that Clement, in accord with the Council of Vienne, had declared that "any one who shall pertinaciously presume to affirm that the taking of interest for money is not a sin, we decree him to be a heretic, fit for punishment," and we have seen that Benedict XIV did not at all deviate from the doctrines of his predecessors. Yet Mastrofini is equal to his task, and brings out, as the conclusion of his book, the statement put upon his title-page that what the Church condemns is only exorbitant interest.

This work was sanctioned by various high ecclesiastical dignitaries, and served its purpose, for it covered the retreat of the Church.

In 1873 appeared a book published under authority from the

Holy See, allowing the faithful to take moderate interest under condition that any future decisions of the Pope should be implicitly obeyed. Social science as applied to political economy had gained a victory final and complete. The Torlonia family at Rome to-day, with its palaces, chapels, intermarriages, affiliations, and papal favor—all won by lending money at interest and by devotion to the Roman See—is but one out of many growths of its kind on ramparts long since surrendered and deserted.*

The dealings of theology with public economy were by no means confined to the taking of interest for money. It would be interesting to note the restrictions placed upon commerce by the Church prohibition of commercial intercourse with infidels, against which the Republic of Venice fought a good fight; to note how, by a most curious perversion of Scripture in the Greek Church, many of the peasantry of Russia were prevented from raising and eating potatoes; how, in Scotland, at the beginning of this century, the use of fanning-mills for winnowing grain was widely denounced as contrary to the text, "The wind bloweth where it listeth," etc., as leaguing with Satan, who is "prince of the powers of the air," and therefore as sufficient cause for excommunication from the Scotch Church. Instructive it would be also to note how the introduction of railways was declared by an archbishop of the French Church to be an evidence of the divine displeasure against country innkeepers who set meat before their guests on fast-days, and who were now punished by seeing travelers carried by their doors; how railways and telegraphs were denounced from a few noted pulpits as heralds of Antichrist; and how in Protestant England the curate of Rotherhithe, at the breaking in of the Thames Tunnel, so destructive to life and property, declared it from his pulpit a just judgment upon the presumptuous aspirations of mortal man.

The same tendency is seen in the opposition of conscientious men to the taking of the census in Sweden and the United States,

* For the decree forbidding confessors to trouble lenders of money at legal interest, see Addis and Arnold, Catholic Dictionary, as above; also Mastrofini, as above, in the appendix, where various other recent Roman decrees are given. As to the controversy generally, see Mastrofini; also La Replique des douze Docteurs, cited by Guillaumin and Coquelin; also Reusch, vol. ii, p. 850. As an example of Mastrofini's way of making black appear white, compare the Latin text of the decree on p. 97 with his statements regarding it; see also his cunning substitution of the new significance of the word usury for the old in various parts of his work. A good historical presentation of the general subject will be found in Roscher, Geschichte der National-Oeconomie in Deutschland, München, 1874, under articles Wucher and Zinsnehmen. For France, see especially Petit, Traité de l'Usure, Paris, 1840; and for Germany see Neumann, Geschichte des Wuchers in Deutschland, Halle, 1865. For the view of a modern leader of thought in this field, see Jeremy Bentham, Defense of Usury, Letter X.

on account of the terms in which the numbering of Israel is spoken of in the Old Testament. Religious scruples on similar grounds have also been avowed against so beneficial a thing as life insurance.

Apparently unimportant as these manifestations are, they indicate a wide-spread tendency in the application of scriptural declarations to matters of social economy which has not yet ceased, though it is fast fading away.*

Worthy of especial study, too, would be the evolution of the better modern methods of raising and bettering the condition of the poor; the evolution, especially, of the idea that men are to be helped to help themselves, in opposition to the old theories of indiscriminate giving, which, taking root in some of the most beautiful utterances of our sacred books, grew in the warm atmosphere of mediæval devotion into great systems for the pauperizing of the laboring classes. Here, too, scientific modes of thought in social science have given a new and nobler fruitage to the whole growth of Christian benevolence.†

PROF. RILEY'S paper in the American Association, on the Use of Micro-organisms as Insecticides, has a tone of warning. While much may be anticipated from the new form of application, it is important to avoid exaggerated statements. There is a tendency in the public mind to take as proved what has not yet passed beyond the stage of possibility. In theory, the idea of doing battle against injurious insects by means of invisible germs is very tempting; but it has unfortunately been most dwelt upon by those who were essentially closet workers, and had but a faint realization of the practical necessities of the case.

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* For various interdicts laid on commerce by the Church, see Heyd, Histoire du Commerce du Levant au Moyen-Age, Leipsic, 1886, vol. ii, *passim*. For the injury done to commerce by prohibition of intercourse with the infidel, see Lindsay, History of Merchant Shipping, London, 1874, vol. ii. For superstitions regarding the introduction of the potato, and the name "devil's root" given it, see Hellwald, Culturgeschichte, vol. ii, p. 476; also Haxthausen, La Russie. For opposition to winnowing machines, see Burton, History of Scotland, vol. viii, p. 511; also Lecky, Eighteenth Century, vol. ii, p. 83; also Mause Headrigg's views in Scott's Old Mortality, chap. vii. For the case of a person debarred from the communion for "raising the devil's wind" with a winnowing machine, see Works of Sir J. Y. Simpson, vol. ii. Those doubting the authority or motives of Simpson may be reminded that he was to the day of his death one of the strictest adherents to Scotch orthodoxy. As to the curate of Rotherhithe, see Journal of Sir I. Brunel for May 20, 1827, in Life of I. K. Brunel, p. 30. As to the conclusions drawn from the numbering of Israel, see Michaelis, Commentaries on the Laws of Moses, 1874, vol. ii, p. 3. The author of this work himself witnessed the reluctance of a very conscientious man to answer the questions of a census marshal, Mr. Lewis Hawley, of Syracuse, N. Y.; and this reluctance was based upon the reasons assigned in 2 Samuel, xxiv, 1, and 1 Chronicles, xxi, 1, for the numbering of the children of Israel.

† Among the vast number of authorities regarding the evolution of better methods in dealing with pauperism, I would call attention to a recent work which is especially suggestive—Behrends, Christianity and Socialism, New York, 1886.

REMARKABLE BOWLDERS.

By DAVID A. WELLS.

THE calling of attention, in The Popular Science Monthly for June, 1890, to the evidences of glacial action in southeastern Connecticut afforded by the number and great size of the bowlders in that section of the country, with accompanying illustrations from photographs, has been instrumental in creating no little popular interest on the subject, and in bringing to the attention of the public many other interesting examples of like glacial phenomena that have hitherto almost escaped notice.

Accepting reported measurements, the largest erratic block, or bowlder, as yet recognized in the United States, and probably in the world, is in the town of Madison, N. H., and, according to Prof. Crosby, of the Boston Institute of Technology, has the following maximum dimensions: Length, 83 feet; width, in excess of 45 feet; height, 30 to 37 feet; contents, 90,000 cubic feet; and probable weight, 15,300,000 pounds, or 7,650 tons.

FIG. 1.

Next to this in size is undoubtedly the great rock in the town of Montville, New London County, Connecticut, generally known by its Indian designation as "Sheegan," and also as "Mohegan" (Fig. 1). In the opinion of some, this rock is an isolated granite protuberance, and not a true "erratic" or bowlder; but recent examinations have seemed to completely negative the first supposition. Its approximate maximum dimensions are: Length, 75 feet; width, 58 feet; height, 60 feet; contents, 70,000 cubic feet; weight,

6,000 tons. If allowance be made for an immense fragment which has fallen from its northeast side, the dimensions and cubic contents of "Sheegan" would approximate more closely to those of the Madison bowlder. One point that goes far toward substantiating the claim on behalf of the "Sheegan" rock that it is a true bowlder, is the number of undoubted bowlders of an immense size and of the same granite which exist in comparative proximity. One, about a mile northwesterly, measures 21 feet high, 25 feet long, and 25 feet thick. Another, some three miles southeasterly, and but a short distance west of the Waterford station, on the New London and Northern Railroad (Fig. 2), and whose existence has

FIG. 2.

heretofore been only locally recognized, has almost the same dimensions; with the added peculiarity of a cavity, or rather tunnel, at its base, some five feet or more at the entrance, and extending with diminishing dimensions completely through the whole mass of the rock, which is about 25 feet in thickness. This cavity, which is somewhat imperfectly shown in the accompanying picture, is of such capacity that it has been fitted up with a cooking-stove, and has served a tramp family as a summer residence.

But one of the most curious and instructive examples of the disruptive and motor power of moving ice during the Glacial period to which attention has ever been called, occurs on the line of the New London and New Haven or "Shore Line" Railroad, about midway between Guilford and Leet's Island stations, and about a mile and a half from either place. Here, on the top of a narrow ledge of rock, which might almost be characterized as a pinnacle, rising (nearly perpendicularly from a salt marsh, or swamp, on one side) to a height of about 60 feet, rests a rectangular, sar-

cophagus-looking block, 16 feet long, tapering from 7 feet 10 inches in width at one end to 5 feet 10 inches at the other, with an average thickness of 5 feet, and an approximative weight of about 60 tons (see Fig. 3).

The peculiarities of this block, which invest it with unusual

FIG. 3.

interest, are: First, its apparent artificiality; second, the surface on which it rests is so narrow, smooth, and rounded, that, were it not for the blocking of a flat slab of rock (shown in Fig. 4), apparently artificially inserted underneath in exactly the proper

FIG. 4.

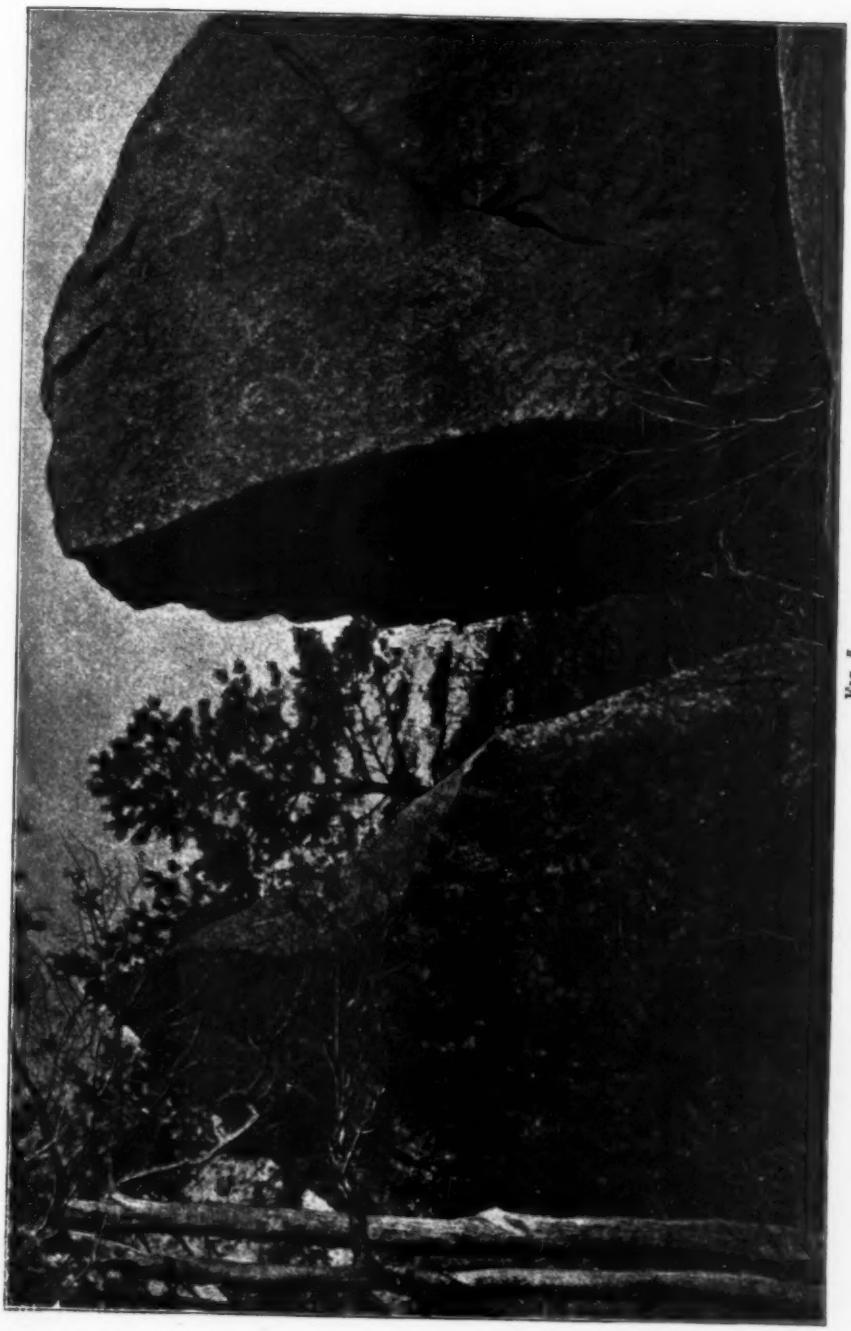


FIG. 5.

place, the block when released—i. e., by the melting of the ice—from the power that transported and placed it must have slid down and found a resting-place at the bottom of what is now a contiguous salt marsh; and, third, the circumstance that all the edges and angles of the block are as sharp and free from abrasion—which last is also true of its entire surface—as if it were but recently lifted from its original bed by the most modern and careful system of quarrying. It could not obviously, therefore, in its process of transportation have been rolled or tumbled about to any great extent; which conclusion in turn suggests that its movement after the first displacement was a lifting up to its present elevation, and that it was not subsequently transported to any great distance laterally. The extension of the ledge on which this great block rests having been largely broken up and removed through its use as a quarry, what might have been evidence confirmatory of this effect is now no longer obtainable. That it would have been perfectly practicable, with the requisite labor and machinery and large expenditure, to have quarried this block, and then have lifted it up and blocked it in its present position, is not to be denied; but the idea that any such thing has been done, and for no practical purpose, is perfectly untenable. The surrounding country is very thinly populated, and the rock was in position long before any quarry (for the obtaining of rough stone for railroad construction) was worked in any immediate vicinity.

To travelers on the New London and New Haven Railroad this testimonial of the forces operative in a former geological age, by reason of its close proximity to the track, is clearly discernible on the right-hand side going west and the left-hand going east, and constitutes a most striking and picturesque object. Its obvious novelty, which has thus far undoubtedly saved it from destruction or displacement at the hands of workmen and vandals, may, it is to be hoped, continue to constitute its protection in the future, although as an object of attraction and interest to tourists and scientific men it is eminently worthy of care by the managers of the railroad company.

Figs. 5 and 6 are photographic reproductions of a huge bowlder, curiously disrupted on the land of Mr. Edward Atkinson, at Mattapoisett, on Buzzard's Bay, Mass., and having the following dimensions: Maximum height, 42 feet; measurement through the middle of the passage between the two fragments, from one side to the other in a straight line, 36 feet; average width of the crack between the two fragments at the level of the ground, 3½ feet; present surface area of the detached fragment, which has in part been quarried away, 462 feet.

To the trained geologist, the foregoing and all similar accounts

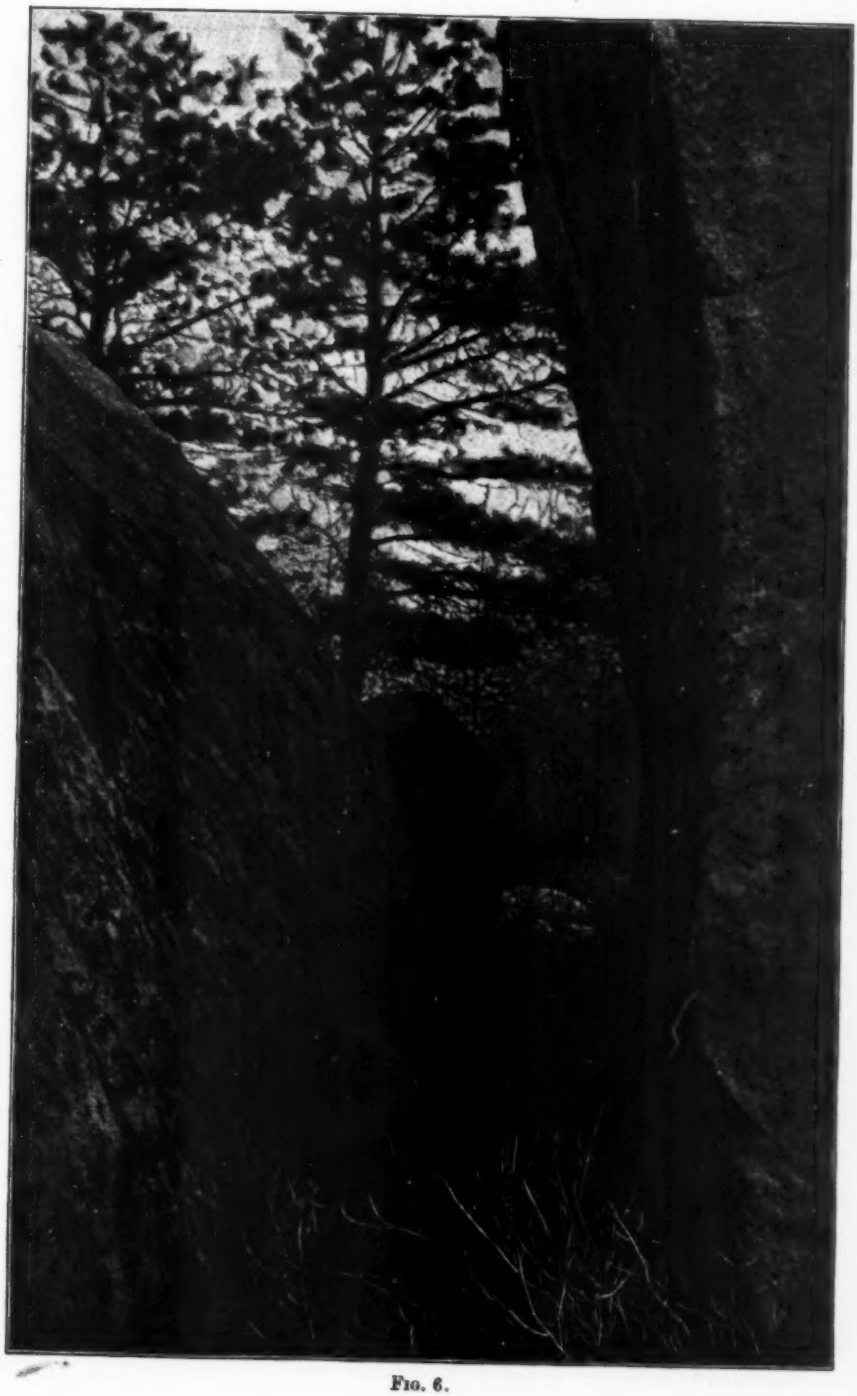


Fig. 6.

and representations of bowlders possess but little interest other than what pertains to peculiarities of size, shape, and location; while the agencies mainly concerned in the formation, movement, and distribution of the bowlder, as well as of the ordinary pebble, which is a miniature bowlder, have long ceased to be matters of controversy. With those not versed, however, in geological evidence and reasoning, the case is far different. To most of such, the attributing of the phenomena under consideration to the motor power of ice seems so fanciful and unnatural that the agency of the Indian (as has come within the experience of the writer) has appeared more reasonable. But if any one thus doubting will but acquaint himself with the present condition of Greenland, where we have a continental area covered with a sheet of ice of immense thickness—a mile or more, doubtless, in many places—continually accumulating through almost constant atmospheric precipitations, and moving, through the weight and pressure of such increments of snow and ice, with almost irresistible force from the center of such continent to its sea or coast line, and then in imagination transfer and reproduce such conditions (which are undoubted actualities) over the whole of the northern United States and Canada, he will be abundantly satisfied that the most striking of bowlder phenomena constitute but a very small measure of the forces that were concerned in their production and were concurrently exerted to modify the earth's surface —even to the extent of removing mountains.

It will also widen the sphere of interest in this subject to refer to the humbler but at the same time most instructive memorials of the Glacial period, which are, as it were, associated with the bowlders, and help to conceal the barrenness and desolation of the "drift"; namely, the pretty flowering plants like the "dandelion" and the "trailing arbutus," and others, which are believed to have come down in the Glacial period from their natural habitat in the far north to our present temperate zone, and to have remained, after the disappearance of the ice, with the bowlders as if to keep them company. Recent explorers of Greenland tell us that wherever in little sheltered nooks upon its dreary coast the ice and frost relax sufficiently in the brief summer to admit of any vegetation, these plants grow and flower most luxuriantly, while in their foreign homes they seem, as every one knows, to choose those times and temperatures for blooming and fruition—i. e., in the early spring—which are most in accordance with the conditions of their origin and primal existence; thus apparently reasserting their *ferœ naturæ* as did the old vikings when associated with the more delicate types of southern latitudes.

TAIL-LIKE FORMATIONS IN MEN.

AFTER THE RESEARCHES OF DR. BARTELS, PROF. ECKER, DR. MOHNIKE, DR. ORNSTEIN, AND OTHERS.

TRADITIONS of tailed men are very old and wide-spread. Tailed races are told of in many countries, whose home is, however, usually placed in some little-known region; and the stories of individuals who had tails can hardly be counted. A number of legends on the subject have been collected by Mr. S. Baring-Gould, and published in his Curious Myths of the Middle Ages. This author himself was brought up in the belief that all Cornishmen had tails, and was not undeceived till a good Cornish bookseller, with whom he formed a warm friendship, assured him that this was not the case; after which he satisfied himself that the man had sat his tail off; and his nurse informed him that that was what happened to men of sedentary habits.

Certain men of Kent were said to have had tails inflicted upon them in punishment for their insults to St. Thomas à Becket. The story runs that when the saint came to Stroud on the Medway, the inhabitants of the place, being eager to show some mark of contumely to him in his disgrace, did not scruple to cut off the tail of the horse on which he was riding; and for this, according to Polydor Vergil, "it so happened, by the will of God, that all the offspring born from the men who had done this thing were born with tails like brute animals. But this mark of infamy, which formerly was everywhere notorious, has disappeared with the extinction of the race whose fathers perpetrated the deed." The story seems to have been applied, with variations, to other Englishmen, now here, now there, so that John Bale complained, in the time of Edward VI, "that an Englyshman now can not travayle in another land by way of marchandyse or any other honest occupyinge, but it is most contumeliously thrown in his tethe that all Englyshmen have tails."

A Polish writer tells of a witch who transformed a bridal company, stepping over a girdle of human skin which she had laid in the doorway, into wolves. She afterward, by throwing dresses of fur over them, gave them their human forms; but the bridegroom's dress was not long enough to cover his tail, and he kept it; whence it became hereditary in his family. John Struys, a Dutch traveler, who visited Formosa in the seventeenth century, relates that a member of his party got separated from the rest and was mangled and killed by a wild man, who was afterward caught and tied up for execution, when, says the traveler, "I beheld what I had never thought to see. He had a tail more than a foot long, covered with red hair, and very like that of a cow. When he saw

the surprise that this discovery created among the European spectators, he informed us that his tail was the effect of climate, for that all the inhabitants of the southern side of the island, where they then were, were provided with like appendages." The cuneiform or Chaldean deluge tablet speaks of the gods, "with tails hidden," crouching down. A Culdee tombstone at Keills, in Argyleshire, Scotland, bears among its figures one of human form, sitting down, and sleeking with his left hand a tail that curls beneath his legs.

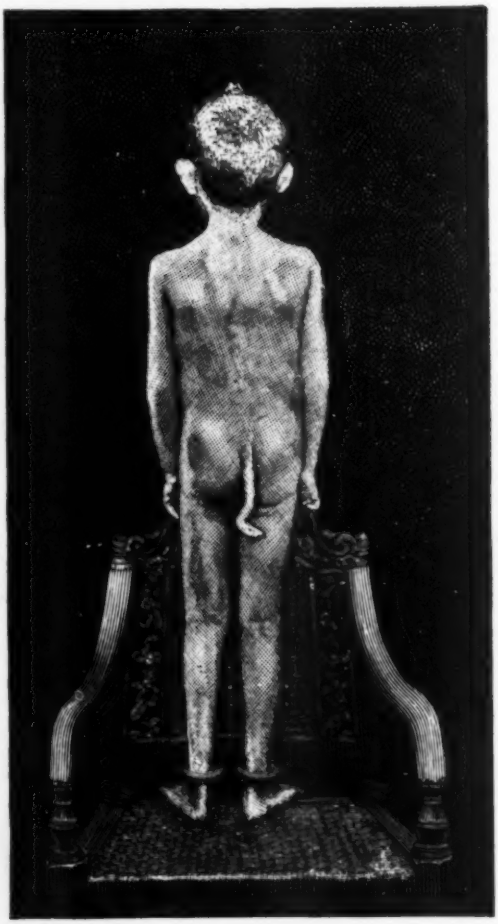


FIG. 1.—TAILED MOI BOY.

Various stories have been told of the tails of the Niam Niams of Central Africa, who have also been asserted to be cannibals. Their tails have been described as smooth and as hairy, as peculiar to the men, and as possessed by the men and women both. The most interesting and circumstantial account of this feature is given by Dr. Hubsch, of Constantinople, who examined a tailed negress. Her tail was about two inches long, and terminated in a point. The slave-dealer who owned her said that all the Niam Niams had tails, and that they were sometimes ten inches long. Dr. Hubsch also saw a man of the same race who had a tail an inch and a half long, covered with a few hairs; and he knew at Constantinople the son of a physician who was born with a tail an inch and a half long, and one of whose grandfathers had a like appendage. The phenomenon, he said, is regarded generally in the East as a sign of great brute force.

The newspapers, many years ago, had a story of a boy, who was born at Newcastle-on-Tyne, with a tail about an inch and

a half long, which, when sucking, he wagged as a token of pleasure.

Apparently well-authenticated instances of human tails are that of a Moi boy, twelve years old, who was found a few years ago in Cochin-China, and had a tail about a foot long—simply a mass of flesh—containing no bony frame (Fig. 1); and the case communicated to the Berlin Anthropological Society in July, 1890, by the Dutch resident at Ternate, of two natives of New Guinea, who had come on board his steamer in Geelvink Bay, in 1880—adult male Papuans, in good health and spirits, well shaped and muscular, who had coccygeal bones projecting four centimetres, or an inch and a half in length. Dr. O. W. Holmes says, in the Atlantic Monthly for June, 1890, that Dr. Priestley, of London, showed him, at the Medical Congress in Washington, a photograph of a boy who had "a very respectable tail."

In The Popular Science Monthly for October, 1884, an account was quoted from Mr. H. W. Eaton, of Louisville, Ky., of a female child that was born in that city with what appeared to be a rudimentary tail. It was visible as a "fleshy peduncular protuberance," about two inches and a quarter long, and measuring an inch and a quarter round the base, shaped like a pig's tail, but showing no sign of bone or cartilage, and was situated about an inch above the lower end of the spinal column. It had grown about a quarter of an inch in eight weeks.

The questions, whether there exists in the human body, in a rudimentary state, a real homologue of the tail of animals, and whether it may sometimes be developed into a member of somewhat similar outward form, have been much discussed by physiologists in recent years. Besides notes on the subject in anthropological, ethnographical, and geographical periodicals, four larger essays have been published upon it, viz.: Mohnike's pamphlet on Tailed Men (Münster, 1878); two papers by Prof. A. Ecker, in the Archiv für Anthropologie (vol. xii, 1879), and in the Archiv für Anatomie und Physiologie (1880, No. 6); and a paper by Dr. Max Bartels in the Archiv für Anthropologie (1880); all of which go into a searching consideration of the subject. The late German scientific journal Kosmos, reviewing these papers a few years years ago, deduced the following conclusions from the evidence then before the world:

The older anatomists treated the question in rather a matter-of-fact way. They regarded the prolongation of the human backbone beyond the *os sacrum*, by three, four, or five vertebræ, without much thought, as the analogous feature of the animal's tail, and called it the tail-bone (*os coccygis*). The phenomenon was not rare to them, nor did it seem wonderful that this part of the body could, contrariwise to its general rule, escape being grown over,

and project free like an animal's tail, or that it might occasionally be prolonged through additions to the number of vertebræ; for they had a deeper insight into the normal agreement of the fundamental scheme in the structure of man and the animals most nearly related to him than some of the physicians and anatomists of our own time seem to have.

But after the great "fall of man," as Ecker expressively calls it, or after man had tasted the fruit of the tree of knowledge which Darwin offered to him, we apparently did not dare to call the thing any more by its right name. We did not venture, according to Prof. His, to speak of the tail of the human embryo, although we could still speak without hesitation of its gill-arch. Man was ashamed, as Ecker has humorously characterized the prudery of the learned, only of his nearer, not of his more distant, cousins. The older anatomists and artists—we name here, as typical representatives of these, only Harvey, Meckel, and Goethe—found it natural that this taillet, instead of bending inward, as usual, toward the pelvis, and being buried in the muscular part, as though that were, of course, one of man's particular characteristics, should occasionally project outward and assume the form of an external tail. They did not regard it as surprising that a formation of this kind should sometimes appear; and they found in the persons who possessed such growths, not, like the men of the preceding age, the consequences of a bestial intercourse or of a fault of the mother; not even a monstrous formation in the common sense of the word, but rather evidence of the adaptability of Nature and of a common type marking all the higher animals. Thus Goethe wrote on the 12th of September, 1787, from Rome: "The tailed men are no wonder to me; but are, according to the description, something quite natural. There are much more wonderful things before our eyes which we do not regard, because they are not so nearly related to us."

The brief essay of Dr. O. Mohnike is based on the fact that all the forms of the backbone of man are related to his erect posture, and that the prolongation is turned inward in order to afford a support to the viscera, which is not needed in animals that go on all fours. He therefore believes that a prolongation of the coccyx outside of the periphery of the rump, analogous to the tail of an animal, would be incompatible with the typical human form, all the parts of which collectively point to the erect gait, and contradictory to it.

A similar inversion is indicated in the anthropoid apes, that have no external tail and sometimes go erect, and is believed by Hyrtl to be produced gradually in dogs and bears that are taught to dance on their hind legs. All this goes to show, if there were

any doubt on the subject, that the *os coccygis* of man is a real analogue of the animal's tail-root, while it also makes clear to us how the same has reached its special form. It is further confirmed by the fact that the inversion in which the coccyx takes part is not observed in the embryonal life of man nor in the earliest infancy, but first appears when the child begins to carry its body erect. The tail-like prolongation of the human vertebral column is evidently a rudimentary formation—an inheritance from the animal condition which, perhaps, persists simply because the inturned vertebra of the *os coccygis* has adapted itself to a new function, instead of becoming useless.

There is found in the human embryo, in the first stage of its embryonal life, just as in other vertebrates, a considerable and conformable tail-structure, which it is not hard to interpret according to biogenetical principles. The length of this taillet, in proportion to that of the rest of the body, is at first considerable. In embryos that have completed their third week the tail is, perhaps, about twice as long as the lower limbs. It is one of the pruderies that still live to vex us that some anatomists, Prof. His, of Leipsic, for example, object to calling this appendage a tail. But Prof. Ecker unequivocally upholds this designation, and in the Archiv für Anatomie und Physiologie (1880, No. 6, p. 442) formulates the following principles in elucidation of the matter:

FIG. 2.—LOWER PART OF AN EMBRYO 15·5 MM. LONG, WITH TAIL. From Ecker.

1. The name "tail" can only be applied to the part of the hinder end of the body projecting over the cloacum.

2. In embryos of the second class—that is, those which are from eight to fifteen millimetres long—the "tail" overtopping the cloacum appears as a free pointed projection upward and forward.

3. This tail consists of a vertebra-containing and a vertebra-free section, the latter of which contains only a *chorda* and a marrow-tube.

4. Only the latter section suffers a reduction, by the *chorda dorsalis* being mostly converted into a knot, while the rest disappears.

5. The vertebra-containing section persists for a longer time than the so-called coccygeal lump. The latter disappears gradually under the surface, chiefly in consequence of the gradually stronger curvature of the *os sacrum* and *os coccygis*, and partly of the more prominent development of the pelvic band and its musculature.

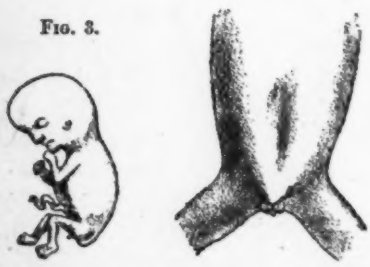
We should also distinguish two processes in the gradual disappearance of the embryonal tail of man: an atrophy of the tail-

point and a shrinking of the tail-root. The former process, the wasting of the hindermost section, takes place, according to the later researches of M. Braun in Dorpat, not only in the human embryo, but also in other vertebrates. "I find," says this naturalist, in his Researches in the Development-History of Parrots (Transactions of the Physico-Medical Society of Würzburg, new series, vol. xv), "in the embryos of swine, cats, sheep, rabbits, mice, and dogs, a long thread at the hinder end of the tail which is sharply distinguished by its tenuity from the rest of the member. The spinal or parted chorda end lies in it in the earlier stage; later it consists only of epidermis cells; and finally it disappears altogether. By this, proof is given that in mammalia as well as in birds the chorda, if I may use the expression, has been carried out too long, and no more vertebræ are formed around its hinder end. It is a striking fact that the long-tailed mammalia are also in this category."

According to Ecker, who confirms the other features of these observations, this attenuated prolongation, designated as a tail-thread, no longer appears in man;* the tail is reduced, much more, according to him, than appears in the sketch, into a conical form. The further wasting process has proceeded so far by the seventh week of the human embryonal life that a tail can no longer be fitly spoken of. Instead of it there is to be seen on the hinder end of the body only a roundish process, the coccygeal lump (Figs. 3 and 4), on which a few minute excrescences, perhaps rudiments of the atrophied invertebrate part of the tail, are visible. This coccygeal lump retains to the end of the third month the form of an acute isosceles triangle, the broad base of which rises in the region of the coccyx without a clear dividing line, while its point ends over the rectum. Two converging shallow furrows define the lateral boundaries between the coccygeal lump and the buttock, over the level of which it plainly rises. Beyond the rectum begins in the continuation of the median line of this triangle the suture, which in the male embryo extends as a plainly marked selvage over the perinæum. What is called the coccygeal lump in the human fœtus is a prominence so brought

Fig. 4.

Fig. 3.



Figs. 3 and 4.—Embryos in the Coccygeal-lump Period. Fig. 3, 4·1 cm. long; Fig. 4, 14·8 cm. long. From Ecker.

* In mammals Ecker sometimes found the tip of the tail-thread so sharp and horny that the name tail-spine seemed to be more appropriate, and he suggests that possibly the well-known tail-spine of the lion is nothing else than the persistent embryonal tail-thread.

forward that the point of the nearly straight-running coccyx is pushed against the skin and lifts it up. Inversion has at this time not yet taken place.

From the third to the fourth month the human fœtus receives its clothing of wool-hairs, which penetrate obliquely through the skin, and form hair-lines converging against the tips of the coccygeal lump, and represent there a vertebra. This vertebra—*vertex coccygeus*—constitutes in several cases observed and described by Ecker and other investigators (Fig. 5) an evident pencil of longer hairs, a real hair-taillet, such as Grecian art gave at the same point to fauns and satyrs. It has already been shown by Eschricht that the converging hair-tuft in the region of the coccyx is analogous to the similar arrangement of hairs on the tails of the mammalia. Chr. A. Voight has expressly noticed the same relation in his treatise on the direction of hairs on the human body (Denkschrift of the Vienna Academy, 1856). "The parts of the skin on which converging tufts are formed," he says, "are either places which were quite bare in the earlier periods of development, or they are spots that covered the prominent bones (or cartilages), the strongly growing parts, like the coccyx, the elbows, and the tip of the ear in animals, or every place toward which an extension of the skin was taking place or had taken place at the time of the development of the hair." This author remarks especially of the coccyx-tuft that, as the hairs become longer, they rise over the surface and form spiral-shaped hair-tufts, like the brushes on the tips of the tails of animals. There is thus again shown a plain original connection between the formation of the tail-shaped attachment and the coccygeal hair-tuft.

Fig. 5.—Coccygeal Hair-tuft. From Ecker.

There is usually found in the human fœtus, above the coccygeal vertebra, a hairless spot, the *glabella coccygea*, under which often appears later, and is even perceptible in persons of middle age, a depression of greater or less depth, the *foveola coccygea*, over the origin and significance of which many and often curious hypotheses have been set forth. It was described by Lawson Tait, in a paper read before the Anatomical and Physiological Section of the British Association in 1878. He had found from the examination of several hundred persons that only fifty-five per cent of them were without traces of the depression or "sacral dimple," while it was faintly marked in twenty-two per cent, and well marked in twenty-three per cent. But it seemed to become imperceptible

again after the thirtieth year of age. Mr. Tait believes that the hollow is associated with the embryonal process connected with the neural canal and its closure. He referred to the tailless cats of the Isle of Man, and tailless guinea-pigs which, like man, possess only an *os coccygis* with three pronged centra infolded in the skin; and thought that he might conclude from certain indications that some of these animals, and perhaps also the predecessors of man, may have lost the tail in consequence of a malformation, probably in man through the not rarely appearing *spina bifida*. We well know how such malformations tend to become hereditary; and the sacral dimple might be called the scar of the lost tail. The hereditability of such malformations is well marked. When Dr. Wilson crossed a Manx tomcat with a common cat, seventeen out of twenty-three kittens were tailless; but when female cats of the Isle of Man were crossed with common tomcats all the kittens had tails, though somewhat shortened. Prof. Ecker has suggested a less fanciful explanation of the origin of the sacral dimple. He supposes that the later inward curving of the tip of the much straighter coccyx in the fœtus—which is connected with the skin by the caudal ligament—draws the corresponding spot on the skin into a funnel shape of greater or less depth. On the other hand, Ecker would rather regard the *glabella coccygea* as the lower fontanel, or later point of closure of the sacral canal.

The embryonal processes and normal conditions of formation thus briefly sketched are sufficient in general to permit most of the cases of so-called tail-formations in men, which occur with tolerable frequency, to be recognized as easily explainable irregularities of natural growth. The case deviating least from the normal condition concerns only the skin-covering, and exhibits itself in an excessive hairiness of the sacral and coccygeal region (*trichosis sacralis*). We have seen above that this spot in the embryo regularly bears a hair-twirl, which is not rarely prolonged into a hairy pencil or taillet. We can hardly consider it an important variation if this hairy taillet is exceptionally not absorbed, but endures and grows stronger after birth. In the so-called hairy men we evidently have persons in whom, according to all appearance, the wool-hair of the fœtus has grown to a far greater extent, or at least possesses the same properties of alignment and direction. The chief physician of the Greek army, Dr. Bernhard Ornstein, having observed several cases of extraordinarily abundant hairiness in the sacral region among Grecian recruits, has given continued attention to this phenomenon, and has determined some very remarkable cases of it. The most striking of these cases was that of the twenty-eight-year-old recruit Demeter Karus, of the eparchy of Corinth. The whole sacral region appears to be cov-

ered with a thick, dark-brown hairy growth, about three inches in length, which spreads over on to either side. The hairs lie more smoothly on the border of the skin covering the sacrum, while in the middle they curl out into two strong tufts. The man is about five feet two inches high, and his yellowish-brown skin shows elsewhere on his whole body less than the usual hairiness. The recruit said that he was born with this unusual hair on his back, and that he had even in youth suffered on account of it from the curiosity of the people of his native village. He said also that the growth had once been so strong that he had braided the hair into queues and tied it in front, but that since then he had preferred to cut it from time to time. To test the accuracy of this assertion, Dr. Ornstein forbade his cutting the hair for a considerable period; and eight months afterward (December, 1875) the sacrum-hair had grown to double its former length, or to six inches; so that the recruit's assertions respecting it were shown not to be incredible.

Prof. Virchow accompanied the detailed communication of this case to the Berlin Anthropological Society * with a few well-chosen words prefacing the opinion that we have perhaps to deal here with a *spina bifida occulta*, which is indicated exteriorly, as occurs often in the case of moles, mother's marks, etc., by augmented growth of hair. There has existed, he said, for a considerable time, a doctrine—we might call it a superstition—in pathological anatomy, which is called the law of the duplication of cases. "On the same morning that I received the letter from Athens, it was told me that there was a corpse in the Pathological Institute which exhibited an unusual hairiness on the back." Since we had to do in this case with a *spina bifida occulta*, there might perhaps be a similar pathological cause in the case of the Greek recruit. But the hair on the Berlin woman's back sprang from a higher spot, and did not denote the more thickly haired coccygeal region of the human embryo. In continuation of these efforts of Virchow to follow up these abnormal formations in the human body resembling animal shapes to their pathological causes, and in order to learn how to obviate them, Surgeon-General Ornstein kept watch upon the parts of the body concerned in the eruption, and in the next year (1876) succeeded in establishing a second case of well-defined sacral trichosis, marked by thick, dark-brown hair, extending to the coccygeal region. In the next year (1877) ten other cases fell under his attention, by which it became evident that this sacral hairiness was not rare in Greece and the islands of the Ægean Sea; and he was convinced that in all the cases the basis of it was normal and there was no question

* Sitzungsberichte der Berliner anthropologischer Gesellschaft in der Zeitschrift für Ethnologie, 1875, pp. 91 and 279.

of a *spina bifida*. Virchow's law of the duplication of the cases had not maintained itself under the first test. Of the various other persons of this kind whose photographs Dr. Ornstein took, we mention the recruit Q. G. Nikephorus, of Siphno, twenty years old, in whom the thick brown hair of the sacral trichosis is very sharply defined, and quite covers the sacrum. The hairs were in this case from one and a half to two and three quarter inches long, while no abnormal hairs were visible on the rest of his somewhat slender body.

It requires no particular gift for adapting evidence or of divination to infer from these cases of sacral trichosis, so frequent in Greece, which are easily explained by reference to the embryonic hairy covering, that the representations of Silenus and the fauns in ancient Grecian art, in which this part of the body is furnished with a tail-tuft of hair, may be traced back to casual observations of such cases in real life. A strikingly naturalistic illustration of this view is afforded by the Silenus with the Bacchus child in the Louvre, in which, instead of the isolated horse-tail-like pencil rising from the sacrum, characteristic of most figures of the kind, the whole sacral region is represented as well haired, while the central lock is simply more strongly prominent (Fig. 6).

FIG. 6.—PART OF THE BACK VIEW OF THE SILENUS WITH THE INFANT BACCHUS, IN THE LOUVRE. From a Drawing by F. Schäfer.

What might be called "hide-bound tails," of which Dr. Bartels describes a well-marked case that occurred in his own medical practice, incline more decidedly to the order of real malformations. In a three-days-old child, the skin over the coccyx formed a three-sided lump of about the shape of the tail-termination of the embryo. This lump was about seven eighths of an inch long, rose several lines above the rest of the skin, and was separated from it by a plainly defined groove. The pointed lower end of the swelling seemed to lie directly over the anal orifice, which was very narrow, and must have been operatively enlarged after the

point of the excrescence had been loosed from that part. The formation did not contain any vertebra; the coccyx lay rather beneath, and there was evidently in this, as in a similar case observed by Labourdette, a question of a so-called intercepted formation from the coccygeal lump period. The hide-bound tail offers an enlarged copy of the embryonal coccygeal lump, and exhibits that lump, which in the normal development reverts and is merged in the buttock, apparently maintained and associated, as a rule, with an imperfect development of the anal orifice (Fig. 7).

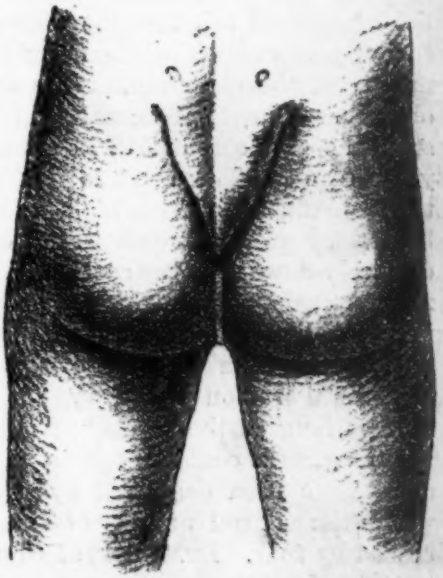


FIG. 7.—THREE-DAYS-OLD BOY, WITH HIDE-BOUND TAIL. From Dr. Max Bartels.

A third class is composed of the "soft tails," which depend freely from the sacral and coccygeal region and are the most frequent. They have sometimes the form of a swine's tail drawn out to a point; sometimes that of a thicker fleshy appendage only slightly rolled at the end. Such soft tails, which belong to the largest of their kind and are both naked and hairy, have been observed and described, among others by Blancart, König, Elsholtz, Schenk, von Grafenberg, and Greve. The last author sent a tail three inches long (Fig. 8), which he had amputated from a boy eight weeks old, to Prof. Virchow for a more thorough examination, and he found that it was not a simple case of skin formation, but that there lay within the inner cell-texture of the skin a fatty bundle penetrated by large vessels. In this species of malformation—to which the case delineated in Virchow's Archiv für pathologische Anatomie, vol. lxxxiii, No. 3, seems to belong—we have to do, not with a simple impeded formation, such as the last-mentioned case is considered to be, but with the outgrowth of a part existing in the embryonic plan, which, however, disappears in regular growth, into a monstrosity *per excessum*, as was the old form of expression. In many respects these cases are atavistic. The

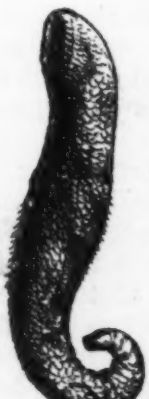


FIG. 8. — AMPUTATED TAIL OF A BOY EIGHT WEEKS OLD. From Greve.

surplus length of *chorda* persists without there being any vertebræ formed upon it.

Real vertebral tails, in which the vertebra-containing part of the embryonal tail remains without being grown over and the coccyx preserves its original straighter direction, have been, if we may trust the older anatomists and physicians, not very rarely observed. Surgeon-General Ornstein, a few years ago, carefully studied such a case in Athens in a Greek from Livadia, twenty-six years of age. There was in this case a conical tail, free only at the tip, about two inches long, within which three vertebræ might be felt by pressing upon it. It did not, however, hang perpendicularly down, but the coccyx was slightly, though less than in normal cases, bent inward. Notwithstanding its apparent firmness, this little movable tail was not distinguishable by the color of its skin from its surroundings. It was hairless, although the sacral region was very hirsute. The free part was not half as long as the whole.* While only three shrunken vertebral fragments could be felt in this case, free tails of like character have been described by several of the older authors in which the normal number of vertebræ appears to have been exceeded by four. Dr. Thirk, of Broussa, in 1820, described the fat-tail of a Kurd, twenty-two years old, which formed a thick lump and contained four surplus vertebræ. Thomas Bartholinus, also, told in the seventeenth century of a tailed boy who had more than the regular number of vertebræ in the coccyx. Such cases represent true atavistic formations, but have never been verified with as much exactness as is desirable, although the possibility of an appearance of the kind does not admit of reasonable doubt. The phenomena might, in fact, be more frequently recorded were it not that such formations, so long as they do not occasion distress, are carefully concealed for fear of reproach falling upon those who bear them and upon their mothers.

Dr. Bartels makes some pertinent remarks concerning the bearing of these exceptional but not at all rare tail formations among men upon the myths of "tailed races"; and Mohnike has made a valuable collection of the travelers' stories on the subject from the most ancient times. Mohnike believes that the older myths generally relate to apes; but this is not very probable, for the erect anthropoids, which most resemble man, are as tailless as he. The derivation from the custom of many savages of wearing animal skins with the tail hanging down upon the right side is more probable. Schweinfurth also observed among the women of the Bongos a custom of wearing a palm-leaf tail, bound on so as to produce a naturalistic appearance.

* A fuller description may be found in the Zeitschrift für Ethnologie, vol. xi, 1879.

The myths of tailed human races constantly revert to the East Indian islands; and the Dutch captain, L. F. W. Schulze, sent communications to the Berlin Anthropological Society in 1877 concerning cases* partly observed by himself, which were regarded by Dr. Bartels as fully trustworthy. These communications tell us nothing new, for the phenomena occur in cultivated Europe as well as in remote deserts and lone islands. Other reports, like that, for example, of Julius Kögel concerning the Dyaks of Borneo, speak of the frequent occurrence of tailed individuals. Hence a low, beastly race has been supposed, in which atavistic formations occur still more frequently than among higher races further removed from the original condition. Still other reports, and more recent, mention fully tailed human races.

Even if a phenomenon of this kind were established we need not, as Dr. Bartels has justly remarked, conceive of a still living middle form between man and beast. "We must consider," he says, "that we are all the time dealing with insular populations who have been crowded out of the possession of their coast and harbor regions by people of other races and driven into the hardly accessible interior of the country, where they have been compelled to practice, for a length of time we can not estimate, a constant inbreeding—a regular series of marriages within their own tribe. In this case there might, at some time in the past, as has happened with other men, have occurred an external tail, as a casual abnormity at first, but which might afterward, in the course of generations, become transmitted to many persons by inheritance. For it has been shown by researches in this interesting field of pathological anatomy that nothing is more easily transmissible than malformations. In illustration of this fact we need only mention here the well-known inclination to the inheritability of what are called mother's marks and hare-lips, and the large teeth of the Melanesians of the Admiralty Islands and the island of Agome, which have been described by Mr. Miklucho-Maclay.† In a similar manner Lord Monboddo, in the last century, explained the tailed men of Borneo as a people afflicted with a hereditary malformation, and compared them with six-fingered families.‡

In agreement with this is what the Wesleyan missionary George Brown related in 1876 concerning a formal breeding of a tailed race of men in Kali, off New Britain. "Tailless children," he says, "are slain at once, or they would be exposed to general ridicule."* A tailed family of princes have borne rule in Rajpootana and are earnestly attached to the ancestral mark. Dr.

* See Kosmos, vol. i, p. 166.

† Bartels, p. 4.

‡ Kosmos, vol. v, p. 449.

* Mohnike, p. 8.

Quatrefages also speaks of the appearance of such varieties of men as very probable. The care just mentioned as having been taken of the malformation is all the more striking because the tail, as has been shown in the European cases, is in sitting and riding no very pleasant feature. They tell of canoes in the East Indies that have holes made in the benches of the rowers. But it is not an idle thought in this matter to suppose that the benches, like the old German stools, were furnished with holes for ornament, or in order that they might be more easily handled and disposed of, and the incident can not be regarded as confirming the popular legend. The result of these investigations is, as a whole, that a formation, homologous even in outside appearance with an animal's tail, is originally present in the human fœtus, and loses its external characteristics at a later period of life through arrest of growth, inversion, and waste. If these processes occasionally fail to take place, the tail-feature is nevertheless not visible in the grown man, and we can not draw from such malformations, even if they appear frequently in a single race, any one-sided conclusions respecting there having existed a former animal-like condition. For it may be supposed with much more probability, from the similarity of the forms in this feature of man and the anthropoid apes, that their common ancestor had already shed the external tail; and hence that the prolongation of the chorda in the embryo, with no vertebra contained in it, may be regarded as a reminiscence of a still earlier ancestral form.

A DISCUSSION in the International Geological Congress at Washington, on correlation of strata, was opened by Mr. G. K. Gilbert, of our Geological Survey, who spoke first of local methods, where one rock lies upon another. Physical continuity was a means of correlation, and perhaps the best method, but was subject to limitations. Traces were rarely possible for great distances. Indirect methods must be resorted to. Beds of similar lithologic formation could be regarded as chronologically similar. Another method was the sequence with which the deposits were laid. Layers following in sequence in different localities argued the same conditions. There were limitations, however, to the use of both these methods. Physical breaks afforded a fourth method of correlation, to which the limitation would probably be distance. Simultaneous relations of bodies to some physical event often afforded valuable evidence. This method had been useful, both at Salt Lake and on the Atlantic coast. Other aids in correlation were the relation of deposits to some geological climate and the evidence of similar physical changes. The similar action of gases in different beds showed chronological similarity. This method was largely limited by local climatic changes, and generally the physical methods mentioned were all valuable at short range but of little use at long range. The theoretical methods, in which floral and animal life are called in, are perhaps more accurate. Of these are divergence from a status at a fixed date, and the relations of the fauna contained in the deposits to climate. The value of a fossil species for purpose is dependent greatly on the length of its life and the range of its space. Long life is a drawback, that makes the cor-

relation vague. Prof. Zittell, of Munich, did not think the method of correlation by plants accurate. Of animals, those of the land were most valuable. He spoke of the difficulty of correlation in some countries where vertebrate animals are not found in many of the deposits. Prof. Marsh agreed with the other speakers that vertebrate animals afforded the best and most accurate material for correlation. Prof. Charles D. Walcott spoke of the advances that had been made in the study of correlation, and illustrated his positions by reference to the Cambrian strata of North America. Prof. James Hall begged that geologists in search of correlations should not neglect physical methods, and described an early attempt at correlation made by himself in trying to connect the rocks of western New York with the deposits of the West.

COMMUNICATION WITH THE PLANETS.

By M. AMÉDÉE GUILLEMIN.

STRIKING discoveries in astronomy, of a character to excite the public mind, have been rare in recent years. Those who have kept in current with the work that has been done in that science are not ready to believe that this is because progress has not been made in it. As evidence of the new work accomplished by its students, and potentially fruitful work, too, we cite the preparation of a map of the sky, accomplished by the aid of photography, which gives the exact position of the stars to the fourteenth magnitude. The co-operation of observatories certainly assures the success of this immense work, which is now in process of execution. La Nature has made known the beginnings and has kept its readers in the current of the very minute and profound preliminary studies, without which the undertaking of operations of an extreme delicacy might have been compromised. It has also made clear the importance of the results to be obtained, and of the various consequences that would necessarily accrue from them. The problems of parallax or of stellar distances, of the proper motions of the stars, of nebulæ, the search for minor planets and new comets, everything relative to the constitution of sidereal systems, may, by an attentive study of the plates of the new celestial maps, receive positive solutions. A new horizon is thus opened to science. These are not sensational novelties, like the appearance of a comet with a long, nebulous tail, which attracts the attention of idlers to the sky; but the importance of astronomical observations is not measured by the noise they make in the public ear. Yet, if the prize of a hundred thousand francs, which an honorable lady has recently bequeathed to the French Academy of Sciences, should be gained by some one, the resultant emotion would be legitimate. To establish voluntary and direct communication between the earth and a

planet, or rather between its inhabitants and the inhabitants of a planet, would be something to sharpen the curiosity of the whole world. I do not see that astronomy or mankind would gain anything by it, but what conjectures, what paradoxes, what high fancies, we should enjoy if it were carried out!

The Academy is said to be disposed to accept the legacy, by virtue of a clause like that which makes the Bréant prize an annual recompense allotted to the authors of discoveries tending to advance the solution of the problem of a cure for cholera. In the same way, the income of the capital bequeathed by Madame Guzman will work in favor of investigations relating to the constitution of the heavenly bodies. I do not think I am hazarding much when I assert that it will be a long while before the new prize is awarded, in its totality at least. But this was doubtless not the opinion of the testatrix. Without going deeply into the question—for that would require a long discussion—the probable correctness of my prediction can be shown in a few lines.

To any one well acquainted with the present knowledge possessed by astronomers concerning the physical aspect of the stars of our system, it is evident that only two of the planets are in a condition to encourage the hopes of those who believe in the possibility of interplanetary communications, to wit, the moon and Mars—the moon especially. Its small distance of 240,000 miles, the clearness of its disk, the facility with which minor features can be distinguished upon it with the telescope, the absence of all cloudiness that can conceal spots upon it, make our satellite an eminently fitting body to which to send signals from the earth. We must believe that the inhabitants of the moon have not thought of this, or the numerous observers of its disk, the industrious authors of the lunar maps, the Beers, Mädlers, Schmidts, at least, would have perceived the signals. But stop. Are there, can there be, inhabitants in the moon, where air and water are absent? If there is any point generally admitted, it is the negative of this question.

Under these conditions, it seems idle for us of the earth to trouble ourselves about means of answering the inhabitants of the moon, or of ourselves provoking signals thence; and this is a pity, for the second heavenly body to be questioned, the planet Mars, is infinitely less favorable for the establishment of an interastral telegraphy. At its most favorable oppositions, Mars is still 42,000,000 miles from us, or a hundred and sixty times farther than the moon; while the diameter of its disk is only 25″. According to Schiaparelli, the smallest objects visible on its surface under the most favorable circumstances—such as a bright spot on a dark ground, or a dark spot on a bright ground—must have a diameter equal to a fiftieth part of that of the planet, or about

eighty-five miles. This minimum can, it is true, be reduced by using large objectives permitting stronger magnifying; but even then it is certain that luminous signals, for example, visible from the earth on Mars, must have enormous dimensions.

The inhabitants of Mars, if more advanced in astronomical knowledge than we, as one of our imaginative astronomers supposes they are, would have, in case they should desire to start an exchange of telegraphic communications with their earthly neighbors, to give their signals diameters of miles in every direction. But would they think of it? The reciprocal question to this is the one that puzzles me. The earth, during all the oppositions of Mars, is in conjunction to it. It is lost in the rays of the sun, and invisible from Mars, unless it is in transit over the sun's disk. Then it is a little black, round spot, on which we have every reason to suppose the Martian astronomers will be able to distinguish nothing. The earth will be better situated at the quadratures, but also at a much greater distance.

I stop here, not desiring to discourage absolutely the candidate for the prize of one hundred thousand francs so generously and so imprudently offered to investigators. But my conclusion, which I have sufficiently foreshadowed, is, that the problem of interplanetary communication is still far from solution; and I believe I shall never be contradicted by real astronomers. I have faith in the indefinite progress of the science, while I am convinced that there are limits to this progress; but I believe also that there is no profit in letting the imagination chase chimeras, and I am free to avow that the desired communication is such to my eyes.—*Translated for The Popular Science Monthly from La Nature.*

THE compilation of a digest of the literature of the mathematical sciences was suggested at the American Association by Prof. Alexander S. Christie. The digest should contain everything of value hitherto done in these sciences logically arranged, with each truth or method referred to its discoverer, and the whole thoroughly indexed. Mathematicians throughout the world should be invited to engage in the preparation of the work, and the co-operation of the British Association especially should be secured.

THERE is no doubt that a kind of perception of light exists even among beings that have no visual organs, or where such organs can not be brought into play. The property is perhaps not unlike that by which the growth and movements of plants are largely determined by the relations of light. A number of cases of such skin perceptions of light—which we might call dermatoptic or photodermatic—have been collected and described by M. Victor Willem in a French journal. Tremblay observed that hydras prefer the more illuminated parts of the medium in which they move; and the same has been remarked by Haeckel, Pouchet, Engelmann, and Loeb in *Protozoa;* and other authors have observed in *Bryozoa*, cœlenterates, *Spongiaria*, worms, larvas of arthropods, and isolated organs of mollusks

that they move or are retracted under the influence of light, and in a general way indicate by their way of living the possession of some kind of a perception of light. M. Dubois has studied the contraction of the siphon of the *Pholas*, and M. d'Arsonval has shown that the muscle of the frog is directly excitable by light. M. G. Pouchet observed that larvæ of *Erystalis tenax* tried to get out of the light; and as they acted in the same way after their cephalic antennæform organs had been taken away, he asked whether these buds of future eyes were not adapted to perceive light, or whether the fore surface is not possibly sensitive to it. Engelmann found that certain *Protozoa* moved or remained still according to the character and intensity of the light—not on account of a direct action upon them, but because of the want of oxygen. M. Graber, since Darwin, has shown that the earth-worm, although it has no eyes, is sensitive to light and avoids it, and its sensitiveness seems to reside in its whole body. Finally, M. Loeb has recently made a series of important researches, whence he concludes in favor of a complete identity between the heliotropism of plants and the influence of light on animals, and that a number of blind forms are sensitive to light. The seat of this peculiar form of sensitiveness has not been clearly determined, but is probably in a pigmentary layer under the cuticle. We likewise know nothing certainly of the nature of the sensation. Some think it may be akin to sight, but vague and rudimentary; while M. Forel would compare it with sensations of touch or of temperature. Photodermatic sensibility reaches to the quality as well as the quantity of light, and M. Graber has shown that blind animals prefer some colors to others. But the data on this point do not all agree.

THE MUSK OX.

By HORACE T. MARTIN.

OUR first introduction to the musk ox (*Ovibos moschatus*) carries us back over one hundred and fifty years, when M. Jeremie made his voyage to the northern parts of our continent, and, returning to Paris, took with him a sample of wool obtained from an animal he called the *bœuf musqué*. This name was also employed by Charlevoix, writing from Canada in 1744.

Scientists were thus made aware of the existence of a large mammal, which impressed them at once with its economic value; yet has it refused to come within the range of their keen observation with a persistence unequaled by any animal of its size and importance. It was many years later that the first scientific

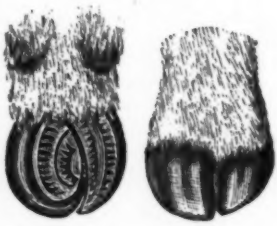
description appeared, given by Thomas Pennant from a skin sent to England by Samuel Hearne, and all acquaintance with the creature was derived from the arctic explorers (Drage, Dobbs, Ellis, Hearne, Parry, and others), who in general terms describe its appearance and give meager accounts of its habits. Dr. Richardson, in 1829, sums up the available information, and adds a few remarks of his own, which refer principally to the specimens then exhibited in the British Museum. Audubon, in his valuable history of the Quadrupeds of North America, published in 1854, is confined almost to a literal copy of Richardson's account; while so late as 1859 Spencer F. Baird, in his ponderous volume, the Mammals of North America, dismisses the subject with a reference of barely twenty lines. His words, however, are significant; for, while he admits that the animal furnishes a most interesting study, he laments our scant knowledge of this sturdy arctic inhabitant.

The special inquiry made three or four years ago by the Government of Canada, as to the resources of the Great Mackenzie Basin, furnishes data of utmost value: the enterprise of the modern press in ferreting out and bringing to our notice every item which concerns itself with the great questions of commerce and social economy, and the progress made in polar research during the last thirty years, contribute many facts in connection with the study of the musk ox; and we are enabled by the gathering and arranging of these to give in a more complete form the history of this animal.

In systematic zoölogy the place accorded to the musk ox is intermediate between those of the sheep (*Ovis*) and the ox (*Bos*), and for its special accommodation a new genus has been created, "*Ovibos.*" Most writers notice its resemblance in many ways to the buffalo or bison, and it undoubtedly has much affinity with this species. A peculiar prominence is given in all early records to the description of the horns of the musk ox, which, though valuable to the Eskimos in the making of such commodities as cups, spoons, etc., by no means seem to be of so much importance, yet in every account the most minute particular of these appendages is repeated. Doubtless much of the character of the musk ox depends on the horns; still, it should be noted that the descriptions above referred to apply only to the bull, whose horns meet on the forehead, bend sharply down, and curve gracefully upward and outward; the cow's horns are more similar to those of the bison, or even may be compared to the horns of our domestic cattle. The skull of the bull musk ox is remarkable for the development of the eye-orbits, which project sufficiently beyond the plane of the frontal bones to compensate for the interruption the horns would otherwise make in the range of vision. The musk

ox, however, does not seem to rely greatly on keenness of sight, far less on acuteness of hearing, for the ears are of small dimensions, and are completely covered by the heavy growth of fur about them. The organs of scent are evidently more highly developed, and they exact of the hunter his greatest cunning. Vasey says the hoof-prints resemble those of the barren-ground caribou so closely as to easily deceive the unaccustomed eye, and concludes a short description of the under parts of the foot with the illustration here reproduced. The external hoof is rounded, the internal pointed.

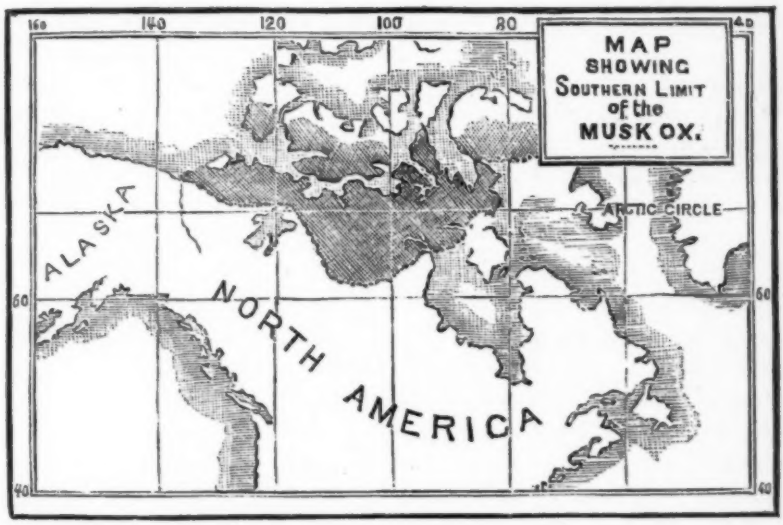
Much diversity of opinion exists as to the size and weight of the animal, and it is evident some statements have been made from very limited observation. Richardson compares the size of the musk ox to that of a Shetland pony, while others assert the dimensions to be quite equal to those of the bison; and whereas the weight has been given as from three to four hundred pounds in the one case, other records claim twice and even three times these figures as the weight of an adult specimen. The addition of from three to six inches of fur on the back, with hair flowing from the flanks to the length of from eighteen to twenty-four inches, gives an appearance vastly different from that of the bison, and the disproportionate shortness of the legs also tends to mislead; but, notwithstanding this, the measurements of the skin show the animal to be almost as large as the bison or buffalo, hence the latter approximation of weight is more correct.



In connection with the color of the hair, it should be observed that, while the summer pelage is usually brownish and corresponds with the descriptions generally given, in winter the animal's covering is a rich black on the head and shoulders, flanks and tail, the color shading beautifully into the milky-white disk on the back, known as the "saddle," while the face and the legs are prettily relieved with the whitish color.

The musk ox is gregarious, and although all early statements agree in estimating the herds as composed of from twenty to fifty individuals, later information greatly increases these figures, and frequent mention is made of herds numbering from two hundred to five hundred.

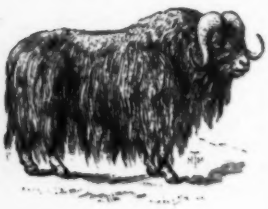
As recently as 1859 Baird says that, owing to the extreme scarcity of the musk ox, he knows of but one specimen to be found in all the museums of the United States. This scarcity, however, might be accounted for more by the fact of obstacles in the way of entering the territories inhabited by the musk ox than by the actual rarity of the animal. From the evidence of fossil remains, it is clear that the musk ox long ago roamed westward to Siberia, and found its way eastward even to the British



Isles; but the accompanying map, exhibiting the boundaries of its present range, shows how restricted is its distribution. In the regions of perpetual snow it wanders, making its way northward in summer, being found at the highest points our expeditions have reached, and returning in winter to its southern haunts, which seldom touch latitude 60°. Over the rugged wilds the creature loves to ramble, and, although its appearance indicates awkwardness of locomotion, it is said to run fast and to climb precipitous cliffs with wonderful ease. Its home is the "barren grounds" wherein vegetation is limited almost to a few lichens and the stunted spruce to which they cling. On this meager diet the musk ox fattened and lived free from the assaults of almost every enemy; for the Eskimo alone penetrated its domain, being urged thither by hunger and the desire to obtain the valuable pelt.

The flesh is much coveted by the Eskimos, and explorers speak in the highest terms of the relish afforded by the meat of the cow and the calf, although the meat of the bull is pronounced as offensively musky. Till within the last five years, in our markets, the pelt was worth fifty dollars, and was accounted a rarity; but

the extreme demand has led to more systematic methods of obtaining it; and whereas the total annual collection of pelts gathered by the Hudson Bay Company had not exceeded a few dozens, the figures have suddenly risen till the annual collection now is counted by thousands.



With the last remnants of the mercilessly slaughtered bison still in our markets, and the air filled with the protestations of theorists as to what *might* have been done to preserve those noble herds that thronged our prairies, we have history repeating itself under our very eyes in the case of the musk ox, and it is not venturing too rash a prophecy to state that the present ratio of increasing the catch will exhaust the supply within a decade.

OUR POPULATION AND ITS DISTRIBUTION.

LESSONS FROM THE CENSUS. III.

By CARROLL D. WRIGHT, A. M.,
UNITED STATES COMMISSIONER OF LABOR.

THE population of the United States June 1, 1890, as ascertained at the eleventh census, exclusive of white persons in the Indian Territory, Indians on reservations, and Alaska, was 62,622,250. This figure, considering the imperfections of the system under which it was ascertained, is quite satisfactory. It bears out the reasonable estimates made prior to the enumeration; it does not bear out unreasonable estimates. Barring inadequate counts in a few localities, which will occur under any system, I believe the statement of the population of the eleventh census to be fairly accurate for the whole country; it is certainly within a very small percentage of accuracy—a percentage which would largely disappear, but not wholly, under a census taken in accordance with the system outlined in the preceding articles of this series. Whether accurate or inaccurate, it is not worth while to quarrel with it; it must be accepted, and the political business of the country and all considerations carried on in accordance with it.

At the first census, taken in 1790, the population of the United States was 3,929,214. The following brief table shows the population at all the censuses, the positive increase during the intervening decades, and the percentage of increase:

Year.	Population.	Positive increase.	Percentage of increase.
1790	3,929,214	.....	.....
1800	5,308,483	1,379,269	35·10
1810	7,239,881	1,931,398	36·38
1820	9,638,822	2,398,941	33·06
1830	12,866,020	3,232,198	32·51
1840	17,069,453	4,203,433	33·52
1850	23,191,876	6,122,423	35·83
1860	31,443,321	8,251,445	35·11
1870	38,558,371	7,115,050	22·65
1880	50,155,783	11,597,412	30·08
1890	62,622,250	12,466,467	24·86

The regularity of increase from 1800 to 1860 is striking, and then the influence of the war and of other elements is shown in the serious break in the regularity which occurs between 1860 and 1870, the percentage dropping from 35·11 in 1860 to 22·65 in 1870. With increased industrial and commercial activity the percentage rose again in 1880 to 30·08, but has now receded to 24·86. The influence of immigration upon this great increase in population, and the rate of natural increase since the decade from 1830 to 1840, are shown as follows:

Period.	Natural.	Immigration.	Total percentage.
1830–'40	28·87	4·65	33·52
1840–'50	26·15	9·68	35·83
1850–'60	23·73	11·38	35·11
1860–'70	15·40	7·25	22·65
1870–'80	22·79	7·29	30·08
1880–'90	14·40	10·46	24·86

Until the full data of the census for 1890 are available, it is impossible to make any careful study of the reasons why the natural increase of population should vary so greatly. The highest natural increase during the period of immigration, as shown in the foregoing table, was between 1830 and 1840, it having been 28·87 per cent, the lowest natural increase being during the last decade, when it was 14·40. It seems almost incredible that such a variation could actually occur in the natural increase of population; but this matter must be left for future consideration. The population at the last three censuses has been distributed over the country, in accordance with geographical divisions, as follows:

Geographical Divisions.	Population.			Increase from 1880 to 1890.		Increase from 1870 to 1880.		Increase from 1860 to 1870.	
	1890.	1880.	1870.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
The United States	62,622,250	50,155,783	38,558,371	12,466,467	24·86	11,597,412	30·08	7,115,050	22·65
North Atlantic	17,401,545	14,507,407	12,298,730	2,894,138	19·95	2,208,677	17·96	1,704,462	16·09
South Atlantic	8,857,920	7,597,197	5,858,610	1,260,723	16·59	1,743,587	29·79	488,907	9·11
Northern Central	22,362,279	17,864,111	12,981,111	4,498,168	25·18	4,883,000	38·76	3,884,295	42·70
Southern Central	10,972,993	8,919,871	6,484,410	2,053,522	23·02	2,484,961	38·32	665,752	11·54
Western	3,027,613	1,767,697	990,510	1,259,916	71·27	777,187	78·46	371,534	60·02

By this table it will be seen that the largest increase during the last three decades has been in the Western division, consisting of Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California. This division increased its population from 1860 to 1870 by 60·02 per cent; in the next decade, 78·46 per cent; and from 1880 to 1890, 71·27 per cent. It is natural that the greatest increase should occur in the division named.

Some of the Southern States did not show as great a percentage of increase as they would have shown had the census of 1870 been more thoroughly correct; but the imperfections of the census of 1870, which imperfections showed an enumeration probably much less than the real population, when compared with the more accurate census of 1880, resulted in an exaggerated increase between those years; consequently, with the census of 1890 compared with the exaggerated increase between 1870 and 1880, the relative percentage of growth is apparently less; yet, on the whole, the Southern divisions show very satisfactory percentages, as will be seen by consulting the last table.

The increase and decrease of population during the decade of years from 1880 to 1890 show casually that in a very large number of counties the population has really decreased, and an examination of the figures by counties gives proof that in four hundred and fifty-five there has been an apparent loss of inhabitants, arising from an actual decrease in population or from a reduction of territory, the latter being the case in fifty instances, consequent upon the formation of new counties. A real loss occurred in only about one hundred and thirty counties, such losses occurring mainly in the central parts of Maine, New Hampshire, Vermont, New York, northern New Jersey and eastern Virginia, and some localities scattered through Ohio, Indiana, Illinois, Tennessee, and Kentucky. Considerable loss has occurred in southern Michigan and Wisconsin, while eastern Iowa has largely experienced a diminution in population. The ebb and flow of mining operations have resulted in a good deal of change in the totals of mining counties, as, for instance, such counties in Colorado have very generally lost in population, and with the exception of two counties the number of inhabitants in the entire State of Nevada has decreased. The statement as to loss in mining regions is also true of California. The increase, however, in our great Western domains has been over one hundred per cent. The Great Plains have increased rapidly, and so have the agricultural areas of the Cordilleran plateau. Northern Michigan, western and southern Florida, Arkansas, southern Missouri, and central Texas, exhibit a growth that is really phenomenal, and the southern Appalachian region has increased its population largely. Southern New Eng-

and, as well as the most of New York, Pennsylvania, and New Jersey, show the results of commerce and manufactures, where they are firmly established and constitute the leading occupations of the people, which has to a large extent been withdrawn from the country and been grouped in the suburbs of cities and large towns; so the population, which twenty or thirty or perhaps forty years ago did not increase in such localities, is, under the activity stimulated by profitable occupations, increasing rapidly; but in the central parts of Maine, New Hampshire, Vermont, and New York, where the transition from agriculture to commercial and manufacturing industries is still developing, population does not gain with very great strides. The changes from agriculture to commercial and manufacturing pursuits are indicative always of a transition from a permanent to an actively increasing density of population. This is evident in the upper Mississippi Valley and in Virginia, where the transition is becoming apparent. The areas known as the plains of the Cordilleran region are being peopled rapidly. This is particularly true in the northern portions. Cheap lands and easy tillage of the virgin soil are making the competition of Eastern agriculturists unprofitable, and so the farming population of the far Eastern States is recruiting the territory embracing the rich lands of the West. In Nevada we witness the peculiar spectacle of a loss of population resulting from the low condition of the mining interests. These facts as to increase and decrease give an indication of the ever-changing features relating to the density of population in great areas.

Taking the whole country, the progress of growth has been along the thirty-ninth parallel of latitude. The center of population, meaning thereby the center of gravity of the population of the country, each individual being assumed to have the same weight, was, in 1790, twenty-three miles east of Baltimore, Md. In 1890 it was twenty miles east of Columbus, Ind., five hundred and five miles west of the point at which it was located one hundred years ago. The variation of the center from latitude 39°, north or south, has been very slight, the extreme having been less than nineteen minutes, while the movement in longitude has been nearly 9¼°. On the basis of a uniform movement on the thirty-ninth parallel of latitude, the westward march for the first decade after the census of 1790 was forty-one miles; for the second, thirty-six miles; for the third, fifty miles; for the fourth, thirty-nine miles; for the fifth, fifty-five miles; for the sixth, fifty-five miles; for the seventh, eighty-one miles; for the eighth, forty-two miles; for the ninth, fifty-eight miles; and for the tenth, forty-eight miles, or an average movement each decade of fifty-five and a half miles. The position of the center of population at each census is accurately shown by the following table and the map which accompanies it:

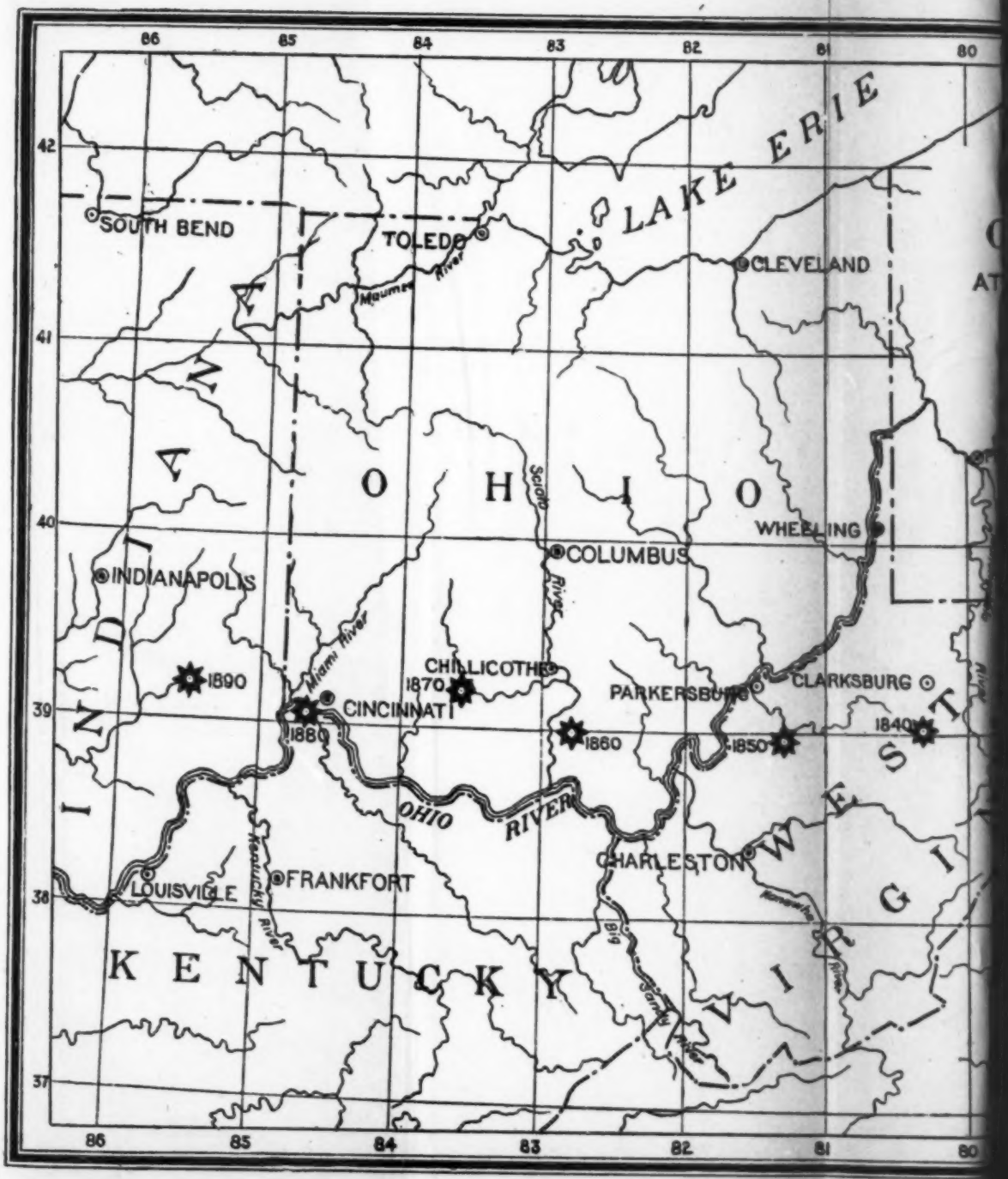
Years.	Approximate location by important towns.	Westward movement during preceding decade.
1790..	23 miles east of Baltimore, Maryland	.....
1800..	18 miles west of Baltimore, Maryland	41 miles.
1810..	40 miles northwest by west of Washington, Dist. of Columbia	36 "
1820..	16 miles north of Woodstock, Virginia	50 "
1830..	19 miles west-southwest of Moorefield, West Virginia	39 "
1840..	16 miles south of Clarksburg, West Virginia	55 "
1850..	23 miles southeast of Parkersburg, West Virginia	55 "
1860..	20 miles south of Chillicothe, Ohio	81 "
1870..	48 miles east by north of Cincinnati, Ohio	42 "
1880..	8 miles west by south of Cincinnati, Ohio	58 "
1890..	20 miles east of Columbus, Indiana	48 "

The official statements as to the center of population and as to the distribution of population in other respects, as will be shown, have been very carefully prepared by Mr. Henry Gannett, the able geographer of the tenth and eleventh censuses; but the statements have been made in various bulletins, and are here brought together in connected and compact form, with proper explanations.

It becomes interesting to know how the population of the country is distributed relative to what are recognized as drainage basins, which may be classified as the Atlantic Ocean, the Great Basin, and the Pacific Ocean. The classification of drainage areas under the first great division, that of the Atlantic Ocean, as a primary designation, has for its subsidiary divisions the New England coast, the Middle Atlantic coast, the South Atlantic coast, the Great Lakes, and the Gulf of Mexico. The Great Basin, for subsidiary divisions, has Great Salt Lake and the Humboldt River. The Pacific Ocean basin consists, secondarily, of the Colorado River, the Sacramento River, the Klamath River, and the Columbia River and their several great tributaries. The percentage of the total population, distributed over these drainage areas or basins, at the last three censuses, has been as follows:

Divisions.	1890.	1880.	1870.
Atlantic Ocean	96·2	97·1	97·8
New England coast	7·2	7·6	8·5
Middle Atlantic coast	18·3	19·2	20·8
South Atlantic coast	6·8	7·4	7·3
Great Lakes	11·2	10·7	11·0
Gulf of Mexico	52·7	52·2	50·2
Great Basin	0·4	0·4	0·3
Pacific Ocean	3·4	2·5	1·9

The table shows that more than ninety-six per cent of the inhabitants live in the country which is drained by the Atlantic Ocean; that more than one half of the population live in the region drained by the Gulf of Mexico, and that nearly forty-four per cent of the entire population of the country are congregated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LAKE ERIE
SOUTH BEND
TOLEDO
Maumee River
CLEVELAND
INDIANA
OHIO
Scioto River
WHEELING
COLUMBUS
INDIANAPOLIS
Miami River
1890
CHILLICOTHE
1870
CINCINNATI
1880
PARKERSBURG
CLARKSBURG
1840
1860
1850
OHIO RIVER
WEST VIRGINIA
CHARLESTON
Kanawha River
LOUISVILLE
Kentucky River
FRANKFORT
KENTUCKY
Big Sandy River

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81
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LAKE ERIE
CLEVELAND
COLUMBUS
WHEELING
PARKERSBURG
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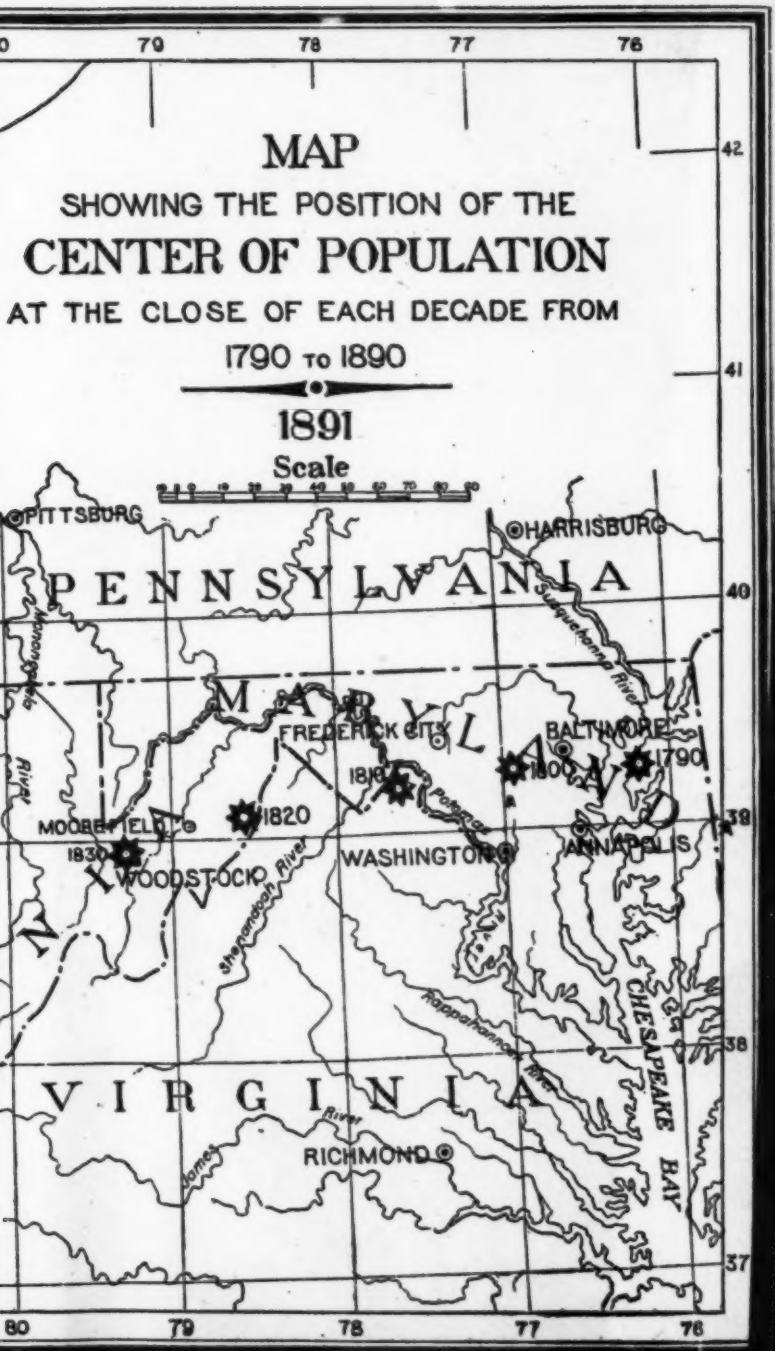
Kanawha River
Big Sandy River


MAP
SHOWING THE POSITION OF THE
CENTER OF POPULATION
AT THE CLOSE OF EACH DECADE FROM
1790 TO 1890
1891
Scale
PITTSBURG
HARRISBURG
PENNSYLVANIA
MARYLAND
FREDERICK CITY
BALTIMORE
1790
1800
1810
1820
1830
MOOREFIELD
WOODSTOCK
WASHINGTON
ANNAPOLIS
CHESAPEAKE BAY
VIRGINIA
RICHMOND
Susquehanna River
Potomac River
Shenandoah River
Rappahannock River
James River
80
79
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77
76
42
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38
37

in the drainage area of the Mississippi River; that only four tenths of one per cent live in the Great Basin, and three and four tenths per cent on the Pacific coast. It shows further that the proportion living within the region drained to the Atlantic is steadily diminishing, while of this region the part drained to the Gulf of Mexico is becoming relatively more populous, as is the case in a still more marked degree in the Great Basin and the region drained to the Pacific.*

The tendency of population, as to topographical features, is best illustrated by a short table which has been condensed from the report of the census:

Regions.	Density of population.		
	1890.	1880.	1870.
Coast swamps	21·5	18·7	15·3
Atlantic plain	74·4	60·2	47·0
Piedmont region	69·5	55·8	45·8
New England hills	40·7	38·6	35·4
Appalachian Mountain region	49·8	41·7	34·3
Cumberland-Alleghany plateau	59·3	49·4	40·7
Interior timbered region	44·3	38·8	31·3
Lake region	25·1	17·6	12·1
Ozark Mountain region	22·8	16·0	10·3
Alluvial region of the Mississippi	23·6	18·2	12·2
Prairie region	28·3	21·2	14·6
Great Plains	1·4	0·4	0·1
North Rocky Mountains	1·1	0·4	0·2
South Rocky Mountains	2·1	1·7	0·7
Plateau region	0·7	0·5	0·2
Basin region	1·4	0·9	0·5
Columbian mesas	1·9	0·8	0·2
Sierra Nevada	4·9	4·6	3·8
Pacific Valley	9·1	5·2	3·5
Cascade Range	5·5	1·7	0·9
Coast Ranges	14·3	9·8	5·8

The greatest density, according to topographical features, is found in the Atlantic plain, it being 74·4 persons to the square mile, and the lowest density is in the Plateau region, it being 0·7 of a person, on an average, to the square mile. Four and three tenths per cent of the entire population of the country is to be found in the coast swamps area and the alluvial region of the Mississippi River. This population consists mainly of the colored race. Two and three tenths per cent of the entire population is found in the desert and semi-desert regions of the country. The mountain regions of the West hold 2·5 per cent, while about one sixth of the entire population is to be found in the Eastern mountain region.

If we examine the distribution according to altitude, it will be found that more than three fourths of the population live below

* Census Bulletin No. 47, by Henry Gannett.

1,000 feet above the level of the sea, and below 5,000 feet altitude nearly ninety-nine per cent of the inhabitants of the country find their residence. At great altitudes but few people are permanently residing. One sixth of the people live less than 100 feet above the sea-level. These, of course, reside along the seaboard and in the swamp and level regions of the South. Those living between 2,000 and 2,500 feet above the level of the sea are found largely on the slope of the great Western plains. Mr. Gannett finds that between 4,000 and 5,000 feet above the sea, but more especially between 5,000 and 6,000 feet, the population is greatly in excess of the grade or grades below it; and he attributes this appearance to the fact that the densest settlement at high altitudes in the Cordilleran region is at the eastern base of the Rocky Mountains and in the valleys about Great Salt Lake, which regions lie between 4,000 and 6,000 feet elevation. In this great region the extensive settlements at the base of the mountains in Colorado are to be found between 5,000 and 6,000 feet above the level of the sea. The mining operations above 6,000 feet, being restricted to the Cordilleran region, largely located in Colorado, New Mexico, Nevada, and California, account for the existence of the population at the altitude of 6,000 feet and more.

The population of the country is increasing numerically in all altitudes, but the relative movement is toward the region of greater altitudes, and is more clearly perceptible in the regions lying between 1,000 and 6,000 feet above the sea. The population is densest along the seaboard, the narrow strip containing our great seaports, as might be supposed; but the density diminishes, not only gradually but quite uniformly, up to 2,000 feet, when sparsity of population is the rule.

If we examine the population relative to latitude and longitude, it will be found that within those degrees in which are located the great cities the greatest density of population occurs, as, for instance, the area between 40° and 41° and longitudes 73° and 75°, containing the great cities of New York, Brooklyn, and Jersey City, with an aggregate population of 3,653,000 inhabitants; the single square degree between latitudes 42° and 43° and longitudes 71° and 72° degrees contains Boston and its suburbs, with 1,233,000 inhabitants, and that square between latitudes 39° and 40° and longitudes 75° and 76° holds Philadelphia, with 1,414,000 people. The square of latitudes 41° and 42° and longitudes 87° and 88°, which contains the larger portion of Chicago, has a population of 950,000. It is difficult to present the facts relative to the distribution of population in accordance with latitude and longitude for the whole country in this summary statement of salient points.

The distribution of population relative to mean annual rainfall indicates not only the tendency of people to seek arable lands,

but their condition as to general healthfulness. The average annual rainfall in this country is 29·6 inches, but the variations range from zero to perhaps one hundred and twenty-five inches. Gauging the distribution of the population in accordance with the average annual rainfall in different localities, some interesting points are observable, not only as to the number of inhabitants in the areas calculated, but as to the density of population. The greater proportion of the people of the United States are living in the regions in which the annual rainfall is between thirty and fifty inches. Mr. Gannett calculates that about three fourths of the inhabitants of the country are found under these conditions; and, further, that as the rainfall increases or diminishes, the population diminishes rapidly. The density of population in regions where the average rainfall is between thirty and forty inches is 43·1 per square mile; in regions where it is from forty to fifty inches annually, the density is 59 per square mile; in regions where the rainfall is from fifty to sixty inches annually, the density is 25·1, and in the arid regions of the West, where the rainfall is less than twenty inches, being two fifths of the entire area of the country, less than three per cent. of the population finds its home. The population has increased rapidly in the regions having from thirty to forty inches average annual rainfall.

The importance of the knowledge of this distribution is supplemented by that with reference to the mean annual temperature, which is in the United States 52°, and the greatest density of population, as might be expected, centers on this pivot, ranging as it does from 50° to 55°. Either side of this range the density of population rapidly diminishes, as it was shown that it decreases rapidly outside the average rainfall between thirty and fifty inches. More than one half of the entire population of the country exists under a temperature between 45° and 55°, while seventy to seventy-five per cent of the inhabitants come within 45° and 50°. Where the temperature reaches 70° on the average, but a little over one per cent of the population finds its home, and the number living under a mean annual temperature above 75° is too trifling for consideration.

This line of facts leads to the consideration of the distribution of population in accordance with the relative humidity of the atmosphere, by which is understood the amount of moisture contained in it in proportion to the amount required to saturate it. This amount varies with the temperature; the higher the temperature, the greater the amount of moisture which it is capable of holding. The term is not a very exact one, but is relative and fairly indicative of conditions. The climate having very great influence upon certain classes of diseases, particularly pulmonary and throat complaints, a knowledge as to the distribution of popu-

lation in accordance with mean relative humidity becomes apparent, and the Census Office is doing a great service in this census, as it did in 1880, in ascertaining the density of population under different degrees of humidity. A condensation of the report by Mr. Gannett on this point will perhaps give as much valuable information to those seeking healthful locations as can be gained from any side of census statistics. It is well known that the atmosphere is heavily charged with moisture in those regions which lie along our coast, whether ocean, gulf, or lake. This is markedly so on the coast of Oregon and Washington, where the atmosphere is more highly charged with moisture than anywhere else within our territory. The Appalachian Mountain regions, and largely those of the Rocky Mountains, have an atmosphere heavily charged; but in the Piedmont region, east of the Appalachian, and in the upper Mississippi Valley, the moisture is less, while it diminishes still more on the prairies and the Great Plains; and in Utah, Nevada, southern Arizona, and southeastern California the minimum amount is reached. Of course the atmosphere is charged with moisture relative to the increase and decrease of the rainfall, as a rule; but throughout the upper lake region, while the atmosphere is as moist as that of the State of Washington, the rainfall is much less, and the coast of southern California has as moist an atmosphere as the Atlantic coast but a deficient rainfall.

The following table shows the percentage of humidity, in classified order, the percentage of the total population of the United States in 1870, 1880, and 1890, living according to the classification of humidity, and the density of population under the same conditions for the same years:

Groups.	Percentage of total population.			Density.		
	1890.	1880.	1870.	1890.	1880.	1870.
Below 50	0·49	0·44	0·35	1·14	0·80	0·50
50 to 55	0·69	0·40	0·24	1·44	0·67	0·30
55 to 60	0·46	0·27	0·16	1·35	0·61	0·28
60 to 65	1·39	0·87	0·35	2·89	1·46	0·45
65 to 70	36·68	38·44	37·31	31·46	26·41	20·26
70 to 75	54·40	54·39	56·76	40·07	32·10	25·74
75 to 80	5·34	4·79	4·49	14·21	10·22	7·36
Above 80	0·55	0·40	0·34	5·55	3·22	2·09

A glance at this table shows that nearly all the population breathe an atmosphere containing sixty-five to seventy-five per cent of its full capacity of moisture; that is, the atmosphere is from two thirds to three fourths saturated. In 1890, 57,036,000 out of 62,622,250 were found in this region; in 1880, 46,559,000 out of 50,155,783; and in 1870, 36,273,000 out of 38,558,371. The num-

ber of inhabitants living in a drier atmosphere was at each census comparatively trifling, numbering in 1870 less than half a million, and in 1890 less than two millions. In the moister atmosphere were found larger numbers scattered along the Gulf coast and the shores of Washington and Oregon. The most rapid increase has been found at the top and bottom of the scale, and particularly in the more arid region, where the population has nearly doubled during each of the last two periods,* showing that great areas that are not particularly favored by the elements are gradually being redeemed through the enterprise that marks our modern industrial era.

AN EXPERIMENT IN EDUCATION.

By MARY ALLING ABER.

FIRST PAPER.

IN October, 1881, a primary department was added to a private school in Boston, Mass., and the control of it given to me, for the purpose of making an experiment in education. While it was hoped the primary would sustain the usual relation to the higher departments, the proprietor † guaranteed freedom of action for three years, and generously furnished the means required. Gratitude is due to others also, especially to the teachers who assisted in some part of the work.

The aim of the experiment was to see if the child may not be introduced at once to the foundations of all learning—the natural and physical sciences, mathematics, literature including language, and history—and at the same time be given a mastery of such elements of reading, writing, and number as usually constitute primary education.

The experiment began with nine children between the ages of five and a half and seven years. With scales and measuring rod each child was weighed and measured, while such questions were asked as—"Have you been weighed before? When? What did you weigh then? How does your weight to-day compare with that?" The shyest children forgot they were at school, and chatted freely while watching and comparing results. By questions as to why a present weight or measure was greater than a former one, the statement "Children grow" was obtained. Questions about the causes of growth led to the statements "Children eat," "Children sleep," "Children play." A question as to whether any-

* See Census Bulletin No. 44.

† The name of the proprietor is withheld, in deference to a request made while the experiment was in progress.

thing besides children grows started a talk about animals, in which were given the statements "Animals grow," "Animals eat," "Animals sleep," "Animals play." In like manner similar statements about plants were obtained. The children were easily led from thinking of a particular child, animal, or plant, to the general conception and the use of the general term. This was the first lesson in natural science.

Recalling the first general conception reached in the science lesson a child was asked, "Nina, what did you say children do?" "Children grow," she replied. I said, "I will put upon the blackboard something that means what Nina said," and wrote in Spencerian script, "Children grow." In response to invitation the children eagerly gave the general statements gained in the science lesson. Each was written upon the board and read by the child who gave it. They were told that what they had said and I had written were sentences. Each child read his own sentence again. This was the first reading lesson.

One by one each child stood by me at the board, repeated his sentence, and watched while it was written. He was then taught to hold a crayon, and left to write his sentence beneath the model. When a first attempt was finished, the sentence was written in a new place, and the child repeated his effort at copying. In this manner each made from one to four efforts, each time telling what his copy meant and what he wished his effort to mean. None of this work was erased before the children had gone. This was the first writing lesson.

The children were led to count their classmates, their sentences on the blackboards, the tables, chairs, and other objects in the school-room. It was found that all could use accurately the terms one, two, three, and four, and the symbols 1, 2, 3, 4 were put on the board as meaning what they said, and their power to connect these symbols with the ideas that they represent was tested in various ways. This was the first number lesson.

The children were shown a magnetic needle and led to note the direction of its points when at rest, and the terms north and south were given. This was the first geography lesson.

After recess each child read his sentence, wrote it once, and then the subject of the science lesson was pursued further. After special answers to the question, "What do children eat?" the general statement was obtained, "Children eat plants and animals." Similarly, the children were led to give "Animals eat plants and animals." Then came the question, "What do plants eat?" One suggested the sunshine, another the rain, another the air, others the ground or dirt, for which the term soil was given. It was concluded that rain, air, and sunshine help plants to grow, and that some of their food must come from the soil; and the

general statement was given, "Plants get food from the soil." Then I asked, "Where does the soil come from?" Before wonder had given way to opinion, I said, "If you bring luncheons and extra wraps to-morrow, we will go to the country and try to find out where the soil comes from." A poem of Longfellow's was read, and the children were dismissed.

On the second morning the children came bounding in before nine o'clock, eager to find and read their sentences, which each did without hesitation; and until nine o'clock they amused themselves finding and reading one another's sentences, teaching and challenging in charming style. A few minutes later we started on our first field lesson in science. An hour's ride in street cars brought us to the open country. We went into a small field where a ledge of rock presented a bold front. "Children," I said, "an answer to our question is in this field. I wish each of you to find the answer for himself, to speak to no one until he thinks he has found it, and then to whisper it to me." Soberly they turned away, and I seated myself and waited. One child looked up at the sky, another at the ground, one began to pull over some gravel, another to dig in the soil—most to do some aimless thing because they knew not what to do. After a while some began to climb the ledge and to feel of it. Suddenly one of these darted to me and breathlessly whispered, "I think the soil comes from the rock over there." "Well, don't you tell," I whispered back. The sun climbed higher, but I waited until the last child brought me that whispered reply. Calling them together, I said: "You have all brought me the same answer. Why do you think soil comes from this rock?" They turned to the ledge, picked off the loose exterior, and showed me the same in masses at the base. A hammer was produced, with which they picked away the rock until it became too hard for them to break. I then said, "We see that a kind of soil comes from this rock, but what kind did we come to learn about?" "The soil that plants get food from," they replied. "How do you know that any plants can get food from this soil?" I asked. Instinctively they turned to the cliff; there were grasses and weeds growing in the talus at the base, and in crevices all up its front and sides; these they pulled, and showed me the roots with the rock soil clinging to them. Referring to the work with the hammer and comparing what they picked off with the hard mass underneath, they were led to variously describe the process of passing from rock to soil, and finally the statement was obtained, "Rock decays to make soil." After luncheon and a bit of play, the children were led to speak of rocks and soils seen elsewhere. Telling the children to shut their eyes and try to picture what I said, I told them that the earth is round like a ball, and is a mass of rock with a little soil on the outside of it; that if a giant could

take the earth in his hand, he might peel or scrape off the soil as we take a carpet from a floor, only the soil would seem much thinner than the carpet, because the earth is so big. All had traveled in railway trains, and had such impressions of their swiftness that this illustration was used: Suppose we start for the center of the earth on a train. Traveling day and night, it would take nearly a week to reach the center, and another week from there to the surface again; and all day while we watched, and all night while we slept, we should be rushing through the rock; and if we came out through the thickest layer of soil, it would take but a few seconds to pass through it. Then, telling them to open their eyes, I took a peach whose rind was thin and peeled smoothly from the pulp, spoke of the giant as I drew off the rind, and told them that the soil is thinner on the rock ball of earth than that rind on the peach. A few remaining minutes were spent in observing some pine trees and barberry bushes growing near.

On the third day, after reading the sentences already on the board—of which each child besides his own read one or more others—the following sentences were easily elicited: "Children eat plants and animals. Animals eat plants and animals. Plants get food from the soil. The soil comes from the rock. Rock decays to make soil." These were written on the blackboard, read, and copied by the children as on the first day. This was the natural science, reading, and writing of the third day. In number, the children added and subtracted ones by making groups and joining and leaving one another. In geography the first lesson was recalled, and the terms east and west associated with the appropriate points.

On the fourth day, after the children had retold what they had learned in the science lessons, they were shown a globe, and asked to imagine one as large as the room would hold, and how, to represent the earth, they must think it all rock, with only a thin layer of dust to represent the soil. In geography they were shown a map of the school-room, and led to see its relations to the room, and the relative positions of objects in the room and on the map. The next day, on another map, they traced their route to the country, and located the field and ledge of rock where their question was answered. In the fifth day's science lesson the children were led to speak of rain and wind as washing and blowing off the decayed rock and exposing fresh surfaces, and so increasing the decay, and to give the following summary: "Without decay of rock there would be no soil; if no soil, no plants, no animals, no people." In reading they had seventeen sentences, which they read without hesitation and wrote with some resemblance to the originals. In number, none failed to count to ten and to add

and subtract ones to ten. Each day a passage of poetry was read at the opening and closing of the session; little songs were taught, gentle gymnastic exercises were introduced between the lessons, and the free-arm movement in making long straight lines was added to their lessons in writing. This work of the first week is given to show how the experiment was begun. The classes entering the second and third years were started with different sets of lessons, but substantially on the same lines.

Throughout the three years reading was taught as in the first week. When there were enough sentences to make a four-page leaflet of print, they were printed and read in that form. The first transfer from script to print was made at the end of six weeks. The printed leaflets were distributed; the children merely glanced at them; as yet they were of less interest than the objects usually distributed. I said, "Look at the papers; see if there is anything on them that you have seen before." Soon one hand was raised, then another, and another. "Rosamond, what have you found?" "I think one of my sentences is here, but it don't look just like the one on the board." In less than ten minutes, by comparison of script and print, they read the whole leaflet, each pointing out "my sentences." After a few readings the children took the leaflets home, the sentences were erased from the boards, and the same process repeated with the new matter that was accumulating. The reader may think there was great waste of time and effort, since the new vocabulary and the written and printed symbols must have been forgotten almost as soon as learned. I expected the children to forget much, and was surprised to find that they did not. One morning in March a visitor who was looking over the accumulated leaflets asked to have them read. I told her they had been read when first printed only; but she urged the test, so I distributed them as they happened to come. The first leaflet fell to the youngest girl, and I think I was more amazed than our visitor when she read it without faltering. The visitor asked her, "What does palmately-veined mean, where you read 'The leaf of the cotton-plant is palmately-veined'?" The child replied, "I can show what it means better than I can tell it." "Show us, then, Marjorie," I said. The child drew on the board a fairly correct outline of a cotton-plant leaf, inserted its palmate veining, and turning to the visitor pointed to that veining. All the leaflets were read without help, nothing was forgotten, neither ideas nor words, as the visitor assured herself by questions.

No effort was made to use a special vocabulary, to repeat words, to avoid scientific terms; there was no drill in phonics or spelling; no attention was given to isolated words as words—a thought was the unit and basis of expression. In the science les-

sons the minds of the children were intent on the getting of ideas and the expression of them. Direction to look or think again usually sufficed to change vague, wordy expressions into clear, terse ones by giving the child clear and accurate conceptions. When the child's own vocabulary was exhausted, he was promptly helped to words by classmates or teacher, the effort being to use the speech of cultivated people.

At first the reading could by no means keep pace with the science lessons: from the mass of expressions obtained some were selected for the reading and writing matter. With increase of power to remember forms and combinations of letters and words, the number of sentences was increased, until what was gained in the science lessons was reproduced in the reading lessons. This increase was rapid. From the first field lesson two sentences—eleven words—only could be taken, while a field lesson near the close of the second year yielded ninety-seven sentences—over eleven hundred words. In the former the sentences were written on the board and read every day for five weeks; in the latter they were taken down in pencil by the teacher as the children gave them, arranged according to topics, printed, and presented in the printed form for the first reading. There was little hesitation in that reading, so vivid were the impressions from such a day out-of-door.

During the first year a little reading matter was drawn from lessons in literature and history. This was gradually increased during the second and third years. Still the sentences for reading were taken chiefly from the science lessons, because there could be more certainty of the child's having accurate and well-defined ideas as the basis of each expression, and the sentences could be more completely their own. In March of the first year reading-books were introduced. At the first trial they took Swinton's Easy Steps for Little Feet, and in twelve minutes read a page-and-a-half story. Of their own accord they sought and independently obtained from the context the meaning of all but two of the unfamiliar words, and gave to express the meanings either the exact words of the book or synonymous ones, for which those of the book were substituted. After this they read from books whenever such reading could be related to their other work—not much otherwise. While the production by the children of the bulk of their reading matter was a prominent feature, this was not the object of the experiment but merely an adjunct to the chief end in view. Nor were the science topics selected with reference to the reading matter, but on their own merits, mutual relations, and the capacities of the children.

As soon as a child's writing on the blackboard could be read by his classmates—copy being erased—he began to write at his

desk with pencil on unruled paper, the copy being still written on the board. When all had reached this stage, concert arm and finger movements were taught. During the second and third years the forms of the letters and combining strokes were analyzed, and each drawn on a large scale to accurate measurements.

The children saw no misspelled words, and were not asked to spell or write isolated words. During the first and second years they usually had a copy from which they wrote. In the third year they wrote original exercises. They were told to ask, when not sure how to write a word. The word was written on the board: no effort was made to have them think how a word should look, no matter how many times they had seen it written and printed.

Work in the natural and physical sciences, starting with broad conceptions, was carried forward along various lines, care being taken to show relations, and to lead the children to regard themselves as a part of nature. In mineralogy and geology, the paving, building, and ornamental stones most used in Boston; the ores of the principal metals, and their products; graphite and the making of pencils; gypsum and halite, were studied, each child getting his knowledge from specimens before him. Each was furnished with a testing outfit, including what a field geologist commonly carries, except the blowpipe and reagents to use with it; and these children from six to ten soon learned to use the outfit with as much skill as any adults whom I have taught.

In physics, lessons were given on extension and gravity; on the solid, liquid, and gaseous states of matter; on heat as the force producing expansion and contraction; on the evaporation, condensation, and freezing of water, with results in dew, clouds, rain, snow, and the disintegration of rocks; on movements of air as agents producing wind and storms; on the thermometer; on magnets, and two of their uses. In chemistry, lessons were given on air and its composition; on combustion and its products; on iron rust as to formation, and effects on iron; on CO_2 as an ingredient of calcite, and a product of breathing; on acids as tests for lime rocks containing CO_2; on the distinction between physical and chemical changes. In astronomy, a few lessons were given on the relations of sun and earth as causing day and night and the seasons.

Botany was pursued in the fall and spring months. In the spring the children planted a window garden, from which they drew plants for the study of germination and growth. From garden and wild plants they studied buds and their developments, and the forms, parts, and uses of some leaves, flowers, and fruits. A series of lessons on plants yielding textile fabrics and the manufactures from them was projected; but, owing to the difficulty

of getting plants in proper condition, the only portion given was that on the cotton plants. Fine specimens of these were received from Georgia, which kept fresh nearly two weeks, and showed all stages, from flower bud to open boll of cotton fiber. No work in zoölogy was done, save the giving of a few lessons on silk-worms and sheep, as yielding silk and wool. In physiology, lessons were given on the general parts of the body: on the joints, skin, hair, nails, and teeth; on the chest, and the process of breathing and its products; on food and digestion—all with reference to the care of the body, keeping the lungs from disease, and the true object of taking food. Geography was connected with science, history, and literature—the original habitat and migrations of rocks and plants, and the location of events leading to imaginary journeys. The forms of water and land, and a demonstration of the shape of the earth by the positions and appearances of vessels at sea, were gained in lessons to the country and the sea-shore. Boston and its surrounding townships were studied in connection with lessons in local history. Maps, globes, compass, and modeling clay were used throughout the course.

While the work in mathematics was not so fully developed on new lines as in other subjects, some work done in the first year may be of interest to the reader. In a field lesson of the second week, some distinguishing features of the apple, beech, pitch and white pine trees were noted and branches obtained. These branches furnished material for many days' number lessons. Apple leaves with their two stipules, pitch-pine sheaths with their three needles, beechnut exocarps with their four sections, and white pine sheaths with their five needles, were used by the children in constructing concrete number tables, which—picking up the objects—they recited as follows: "In one sheath of white pine are five needles; in two sheaths of white pine are two times five needles," etc. When the concrete table was familiar, the same number relations were written on the blackboard with figures and symbols. In this manner the children learned the four classes of tables as far as sixes. Meanwhile the study of geometrical forms and the plant lessons gave illustration and review. In January work with money was begun, and continued through the remainder of the year; but other opportunities to give practice in number were utilized—as, the six faces of the halite crystal, the six stamens of the tulip, etc. To get unworn coins we sent to the Philadelphia Mint. In two lessons the children learned the names and values of one copper, two nickel, four silver, and six gold pieces; in the third, by placing piles of coin side by side, they constructed and learned the table:

Two silver half dollars equal one gold or silver dollar.

Four silver quarter dollars equal one gold or silver dollar.

Ten silver dimes equal one gold or silver dollar.

Twenty nickle pieces equal one gold or silver dollar.

One hundred copper pennies equal one gold or silver dollar.

On the following day a new concrete table was prepared, and the dollar sign, figures, symbols, and decimal point were substituted for the words in the written work. The relative values of the lower denominations to one another were taught, and tables constructed and written. The different denominations of paper money up to the fifty-dollar bill were added to the coins; and this money—about one hundred and fifty dollars—was used in business transactions, which gave review of the number relations already learned, and taught those necessary to the construction and comprehension of the remaining tables. At the end of eight months the children could use and write numbers to one hundred and fifty, and the signs +, −, ×, ÷, =, $, and · (decimal point); and understood the value of position in notation to three places to the left and two to the right of a decimal point. Also, in the oral work with money, they readily used the fractions one half, one fourth, one tenth, one twentieth, and one hundredth; and most of them could write from memory the usual tables from one to twelve. In this first year no effort was made to do a defined kind or amount of work; the children spent from twenty to thirty minutes each day at some mathematical work, but progress and variety depended on their interest and capacities. A visitor who had spent forty years in teaching sat through one of these primary sessions. He expressed pleasure and surprise at the work of the children in science, reading, and other branches, but was incredulous, at first, about the work in number with the money at their desks, and the written work in figures and signs at the blackboards. He went around among the children, tested them, and watched to see if there were not some trick of parrot-like performance. Finally, convinced of the genuine comprehension of what they were doing by these children of six and seven, he said: "I should not have believed it on the statement of any man or woman whom I have known; but I have seen it with my own eyes."

It is a matter of regret to me that growing burdens of care forbade the development of the number work during the second and third years on the lines begun in the first year. To spend from a half-hour to an hour a day for ten years at mathematics, with no better results than the average boy and girl of sixteen can show, looks like a great waste of time and energy. May not the cause be twofold: First, that the beginning work is made silly by its simplicity, and insipid by being related to nothing interesting; second, that processes like the subtraction of large numbers and long division are pressed upon the child before his powers are adequate to their comprehension?

The last fifteen minutes of each day were devoted to literature. Selections with biography and anecdote constituted the materials for these lessons. Advantage was taken of birthdays, anniversaries, and natural phenomena. Storms furnished accompaniments to Lowell's The First Snow-fall, portions of Whittier's Snow-bound, Longfellow's Rainy Day, Bryant's Rain, Shelley's Cloud, etc. Flowers brought by the children were related to readings from Burns, Wordsworth, Emerson, Lowell, Bryant, Whittier, and Longfellow. Emerson's Rhodora was committed to memory and recited, a cluster of the purple blossoms being in sight. Selections were made with primary reference to their value. Biography was usually employed to heighten interest in literature; for its own sake when embodying noble sentiments — as Scott's struggle against debt, Sidney's gift of water to the soldier. By such tales of heroic effort and action it was hoped to develop courage, honor, and devotion to duty.

Aside from clear language in narration, accompanied by pictures of persons and places, and such reading as expresses the rhythm and meaning, no effort was made to have biography or selection understood. Many children have such an appreciation of melody that a fine poem well read will hold their attention. Just before Christmas, in our first year, I read a portion of Milton's Hymn on the Nativity, and said, "I hope you will some day read the whole, and like it." "Please read it all now," said several voices. So it was all read, and the children listened intently. Milton's picture was put away, and nothing said of him for a year. When his picture was again put on the easel, a hand was at once raised. "What is it, Tracy?" "I know who that is." "Who?" "Mr. John Milton." "What do you remember about him?" "He gave his eyes for liberty"—an expression which, so far as my knowledge of the child went, he had not heard from any one, but was his own terse summing up of the narrative he had heard a year before, when barely six years old. Most children have such an appreciation of justice and heroism that they will even walk more erectly after listening to a tale involving these qualities. I shall not forget how gravely and proudly fifty children withdrew from the school-room after listening to the story of Sidney's death. An unspoiled child has usually a vivid imagination; and it is as pernicious to meddle with the formation of his mental pictures in literature, as in science lessons to keep telling him what he can get from his specimens. The child's mind should be brought into direct contact with the realities in history and literature, and left to work at them with the least possible interference and guidance. If a child attempted to repeat a quotation or fact, accuracy was required, but he was not urged to remember. Much in the literature lessons was above the children's comprehension; but it was

thought well for each child to feel a breath from the mountains above and beyond—a breath whose coolness and fragrance he might feel without analysis or comprehension of its qualities. To have felt was enough. So we paid no attention to ordinary poems and tales for little children, but introduced the children at once to Longfellow and Emerson, Wordsworth and Scott, Milton and Shakespeare.

There was regular study of history for each year. Copies of early and late maps of Boston were given to each child; the older one was drawn on transparent paper, so as to be laid over the later one and show directly the changes and extensions into river and harbor. Colored crayon maps and pictures were used to illustrate the historical narrative. These narratives were drawn mostly from local events—as the settlement of Boston, with certain old Boston worthies as centers, about whom incidents were grouped; the beginning of the Revolutionary War with a visit to the Washington elm at Cambridge; some incidents of slavery and the civil war connected with Garrison. Extracts from diaries, letters, etc., were printed on leaflets and read by the children, who drew their own inferences. These readings from original sources were mostly confined to the third and fourth classes, as the language used was too difficult for children of the first two years. Sometimes gratifying volunteer work was done; as an instance, a boy of eight learned the whole of "Paul Revere's Ride," and recited it, standing at the blackboard and tracing on a colored map of Boston and its surrounding townships the route taken by the rider. This work in history was done by Miss Nina Moore—Mrs. F. B. Tiffany—who developed it with such skill as to fascinate the children, and to lead to her publications on these topics. (See articles in Common-school Education for September, October, November, and December, 1888; and the books Pilgrims and Puritans and From Colony to Commonwealth.)

The industrial part of the experiment was started at the beginning of the third year. Each child was provided with a bench and ten tools—ruler, try-square, scratch-awl, saw, vise, plane, chisel, brad-awl, hammer, nail-set. The children of the two younger classes made a box with the cover hinged on with strips of leather; those of the two older, a case with shelves fitting into grooves. The work was divided into steps; each was mastered before the next was tried. All the children began with the use of the ruler in measurements to an eighth of an inch. The try-square came next. As soon as a true line was drawn, the saw was used to divide the board. After the first day no two children were exactly together, each one's position depending on his own results. The third step—the cross-cut saw—detained most of the children several weeks; a true cut with its face at right angles to each

face of the board was required. This the children tested for themselves. Often during the first work with saws a child would ask, "Will that do?" "Test it," was the reply. Reluctantly the child applied the test, and renewed his courage as best he could. After a time the desire to use a new tool and to get on as some other child did gave way to desire for perfection. This brings me to the chief end of the work—not skill in handicraft or any finished products, but to put before the children concrete examples of the true and the false, in such a manner that the child himself should judge his own work by some unvarying standard. As an instance of the moral effects: One of the older boys was the first to finish the shelves and both sides of his case, all but one groove. The excitement of this eminence dizzied him, and that groove was a failure—being too wide, it left an ugly crack above the shelf. No one was more sensitive to that ugliness than he; but the struggle between his desire for perfection and the fancied humiliation of making another side and letting some other child be the first to complete a case went on for some time. Finally, with a manly effort to keep his eyes from overflowing, he laid the faulty side among the failures and began again. To give up the work of many days, and the prospect of coming out ahead, was to win a great battle not for himself alone but for his comrades. For use, the rejected side was almost as good as perfection itself; to ideas of truth and beauty the boy's mind yielded obedience. Such yielding of lower motives to higher ones, such discipline of patience and judgment as these lessons gave, were not reached in any other line of work.

Most public schools for primary children have two sessions a day for ten months; in the experiment there was but one session a day for eight months. In the former, five hours or more a week are spent in reading alone; in the latter, less than five hours a a week were given to the science lessons and to the reading drawn from them. The saving of time in other studies was almost equally great; and besides the large body of superior knowledge opened to the children, the ordinary proficiency in all subjects commonly taught in primary schools was generally reached. This demonstrates the fallacy of the current opinion that children can not be taught science, history, and literature, and at the same time master the usual three r's allotted to them.

But the experiment aimed to introduce the child to the world of real learning, with the idea that such introduction would produce certain effects on his mind; and it is by that aim and those effects that it should be judged. As to the former, the reader has but to examine the body of knowledge outlined, and judge whether it is worthy to be called real learning and the foundation of knowledge.

Among the effects, perhaps the chief place should be assigned to the general attitude toward study. Compare two children trained in the two ways. On entering school both are equally eager and happy. One is kept for the most part away from learning, and laboriously taught to hold the empty wrappers of it; the other is taken at once into the shrine, where he soon becomes at home; and, while he gets wrappers as rapidly as the child outside, every one is full and overflowing. The former grows tired of tasteless drudgery and longs to have school days over; in the latter, nearness to the central fires kindles the sacred flame, and its shining through the fleshly covering makes his face a contrast to that of the other child. One finds the school-room a prison; the other an enchanted land where all is "truly true." If both leave school during the first six years—as so many do—the former is likely to have vague notions about a large field of study, and but little interest in its contents or faith in their value; while the latter will be as likely to preserve sympathy with learning, and desire to advance it in himself and others.

Among other effects may be mentioned:

1. The children learned to ask serious questions. In a lesson on clouds and rain, Emma asked, "Why is the rain not salt, if most of the cloud vapor comes from the ocean?" She was told to dissolve a certain amount of salt, to evaporate the solution over a fire, and note results. On the following day she reported that the same amount of salt was left after evaporation as she had first used, and gave as her conclusion that ocean-water in evaporating leaves all its salt behind; and the youngest boy added, "Then only pure water can float up into the blue sky."

2. They learned that opinion without knowledge is folly. In planting a window garden, they put seeds in pots of earth; I, between wet blotting-papers. Their decided opinion was that my seeds would not grow. A week later they were eager to give this sentence, "The seeds in Miss Alling's garden did grow."

3. They became fond of mental activity. They were not marked, formally examined, hurried, nor required to do a certain amount in a definite time. This freedom and leisure transformed their first laborious, timid thinking into a delight, which they entered upon as spontaneously and fearlessly as upon their outdoor physical games.

4. Their habits of thinking improved. At first they showed but a superficial interest in the objects studied, and much questioning was needed to direct and hold their attention; later, they voluntarily seized upon the marked features of objects and phenomena, and pursued them until practically exhausted. We did not flit hither and thither, giving the children new objects of study each day, but kept them at work upon one so long as it

could yield anything within their comprehension. As an instance, successive lessons on the cotton plant were given for three weeks.

5. Their perceptions became almost unerring. At the Museum of the Boston Society of Natural History, one day, Katherine exclaimed as we rapidly passed a case of minerals, "There's some graphite." Turning and seeing whitish specimens, I said, "Oh, no; have you forgotten how graphite looks?" The child insisted, and we turned back to the case. Sure enough, on one shelf the white rocks contained grains and threads of graphite, which fact the child had gathered in one rapid glance.

6. Memory became active and generally true. It was aimed to pursue all things in order, with regard to natural relations and associations; beyond this the cultivation of memory was committed to the qualities of the ideas presented. The result seemed to prove that memory is retentive in proportion to the activity and concentration of the whole consciousness, and that this is proportioned to the interest of the subject-matter.

7. Imagination was vivid and healthy, producing clear reproduction, apt illustration, sometimes witty caricature, and occasionally thought and expression delicate and lovely enough to be worthy the envy of grown-up *literati*.

8. There was a beginning made in the habits of independent examination of any matter, of honestly expressing the results of such examination, and stoutly maintaining one's own ideas until convinced of error, and then of readiness to adopt and defend the new, however opposed to the old. These habits lead to mental rectitude, robustness, and magnanimity, which qualities confer the power of discriminating values: for pride of opinion gives blindness; the love of truth for its own sake, sight.

9. In waiting for Nature to answer questions—sometimes they waited three weeks or more—and in continual contact with her regularity and dependence on conditions, they gained their first dim conceptions of what law means, and of the values of patience and self-control, and of realities as opposed to shams. Finding in Nature mysteries which the wisest have not explained, a half-conscious reverence stole upon them—the beginnings of true spiritual growth.

At first the experiment called forth much criticism. At home the children told about rocks and plants, and related stories from history and literature, but said little about reading and writing. Parents came to see, and universally condemned the method. One mother said, "My daughter will study geology and literature when the proper age comes; I wish her now to learn reading and writing, and have simple lessons in arithmetic and geography." But she yielded to her child's entreaties, and allowed her to be experimented upon. Later, this mother visited the department to

express her wonder and satisfaction at her daughter's progress in reading, writing, and number. A father, after visiting the department, said, "My boy isn't learning anything; he's having a twaddle of experiments." Three months afterward he said, "My boy's whole attitude of mind is changed; he looks at the world with new eyes, and is also progressing rapidly in the studies common to children of his age."

A criticism frequently met was that the vocabulary was too difficult, and, being largely scientific and technical, could not fit children to read children's books. Experience proved the contrary. Reading for ideas, the children were not deterred by a few unfamiliar words. In reading stories in books, they could usually get the principal ideas; and to infer the meaning of the unknown forms had much novelty and interest. It was also objected that the ideas themselves were too difficult, and could not possibly be comprehended by the children. In a language lesson of the second year, Frank gave the sentence, "The soil is thin." A visitor asked, "Did you ever see a well dug?" "Oh, yes; at my grandfather's, last summer." "Was the soil there thick or thin?" "Thick." "How thick?" Looking from floor to ceiling, "Thicker than from this floor to the ceiling." "Then what do you mean by saying that the soil is thin?" was asked in a mocking, disconcerting tone. Frank dropped his eyes in thought; after a moment he said, "I mean it is thin when you think of *all the way down to the center of the earth.*" This boy entered before he was six years old, and was at this time barely seven.

Teachers who visited the department said, "You have a comparatively small number of children from cultivated families; even similar results could not be obtained in the large, miscellaneous public-school classes." This could be met then by the statement only that mind has everywhere the same elemental possibilities, and must yield similar results for the same influences, although the time required might be much lengthened. This criticism has now been answered in part by the results of a trial made in the public schools at Englewood, Ill., an account of which will appear in a subsequent paper.

The few scientists who knew of the experiment looked on with favor. "It is the ideal way," said one. "A realization of my own dreams," said another. An eminent leader in educational affairs in this country objected that the great majority of our primary-school teachers could not follow in the same line because lacking the requisite body of knowledge. When courses of study for lower schools are made out by eminent specialists with a view to putting into the hands of children the beginnings of their own lines of research, and when school authorities provide courses of lectures and other means of furnishing to teachers the necessary

body of knowledge, I think teachers will, as a whole, be quick to respond to the demand and the opportunity—as a release from the belittling effects of their present monotonous drudgery with trivial ideas, if for no higher motive.

In conclusion, the reader may wish to ask, "Was the experiment, after all, a success?" I answer, "As a demonstration of the possibility and value of introducing little children to real learning, yes; as a realization of my ideals, no." I was conscious that there was much that was superficial in the work; and that, in striving to avoid shadows and to grasp the real substance of education, I often grasped but another and a finer sort of shadow. May some other teacher, having greater fitness for the work, and a longer opportunity for effort, reach the goal for which I started! The instruction such an one could give about primary education is needed all over our beloved land.

THE AVIATOR FLYING-MACHINE.

By M. G. TROUVÉ.

A SUCCINCT history was given by M. G. Dary, in a recent number of *L'Électricien*, of the vain efforts that have been made at different times to steer balloons in the atmosphere. Some of the experiments were, indeed, of real merit; but they did not succeed practically, because the problem they were intended to solve offers insurmountable obstacles. The steering of balloons and the realization of great speed with them are practically impossible, and the results obtained from experiments directed to those objects have not been worth the immense outlays that have been made upon them. Yet balloons styled directable will probably render very appreciable services in military art and under a few other special circumstances. The experiments of M. Gaston Tissandier and Commandant Renard have not been useless, and it will be of some advantage to continue them. But while balloonists are right in seeking to increase the dimensions of their globes in order to increase at once the proportion of ascensional power and of motor and propulsive energy to resistance, we, advocates of machines heavier than the air, looking especially to great speed, would gradually diminish the function of the balloon as a sustainer, reduce it, and bring into greater predominance the propulsory organs, making them at once more powerful and lighter. These are those which, with the motor and the generator, represent the element heavier than the air. When the balloon shall have been eliminated in this way, practical aërial navigation will have been accomplished.

Let us suppose ourselves looking through a glass, eye at the eye-piece, at a balloon. It is large, gigantic, monstrous, the aërostat of to-day. Turn the glass, end for end. The balloon is reduced, and becomes a mere point, imperceptible, lost. Such is, from our point of view, the balloon of the morrow. It is well for the present to use the balloon as a supplementary sustaining instrument; but let us always keep in mind that we shall thank it as soon as possible for its services and show it the door. A hypothesis should be to the physicist simply a provisional artifice for the convenient grouping or explaining of a number of determined phenomena; and, to our view, a balloon is a similar artifice, the present uses of which may be valuable.

We had the honor some years ago of becoming acquainted with MM. de la Landelle and Ponton d'Amécourt, warm partisans and advocates of the doctrine of machines heavier than the air, which originated, according to classical traditions, with Architas. They convinced us, and we have since been their fervent disciple. We are, in fact, a persistent admirer of the simple processes employed in Nature and used in a marvelous way by birds to sustain themselves in the air and guide their flight, and specious calculations have never caused us to doubt the possibility of a solution of the problem of locomotion in the air by wholly mechanical means; and we have long regarded the solution of it as depending solely on the discovery of a powerful and light motor. How many examples does the history of natural philosophy present us of calculations that have deceived—either because their starting-point was false, or because we were mistaken in interpreting the results!

What good does it do to descant on the forms and the details of an air-machine when its most essential part, its soul we might say—its motor—has not been found? Could we give a rational theory of telephony before Bell invented his electric telephone, or of the transmission of force to great distances before the creation of the Gramme machine?

We have received numerous letters during the last twenty years from authors and inventors desiring to submit to us their projects and arrangements of propellers. "It is all very well," we have told them, "but, before sending me anything—have you a motor?" "A motor? No, sir; we have thought about it, indeed, but have depended on you for that." "If I had a motor," I would reply, "I should have no need of your apparatus; I have a thousand of them, and my only trouble is in choosing between them." The motor, in fact, is the essential thing; having that, it is a minor affair whether one prefers the aëroplane, the helicopter, or the aviator; it is a question of return—a question that must be looked into, but which is strictly subordinate to the nature of

the motor. It is not till that is got that calculation should come in, when it can find a sure starting-point, based on well-conducted experiments and precise ideas, and its results will be susceptible of an immediate verification. We have constantly employed this prudent, positive method, and it only can give satisfactory results. This motor, which is to fulfill at the same time the two conditions so hard to reconcile, of great power and extreme levity, we shall now try to describe.

FIG. 1.—BIRD-LIKE GENERATOR-MOTOR AND PROPELLER.

The fact indisputably results from observations, from the positive experiments of M. Marey, from the studies of M. Espitalier, and from our personal labors, that birds expend on an average a motor exertion of 75 kilogrammes per unity of weight—a unity comprehended between 3·6 and 12·5 kilogrammes—in rising vertically one metre per second. Observe that we are talking of gross work, not of useful work effected directly upon the air. Thus Goupil, a respected authority, has found that the work of a horse-power in the pigeon is given for a weight of 12·5 kilogrammes. That is the manifest work, but not the work really developed by the animal; the wing, like the screw, in fact, makes only a weak return.

We select, then, the minimum unity of weight 3·5 kilogrammes per horse-power which results from the experiment with our electrical helicopter, because we know in advance that we can not obtain the full return for the expenditure; and in this weight we must include that of the generator of energy, or of the propeller, and all the accessories.

It is impossible, in this necessarily brief study, to give the

names of all the known motors, and still less of the apparatuses which might be applied as motors. Inventors reserve many surprises in that matter. But, without letting imagination carry us beyond the domain of experimental science, it is allowable for us to consider what satisfaction steam, electricity, and such accumulators of energy as India rubber, steel, compressed air, gas motors, and explosives may give. We are able now, with special precautions, to construct steam motors of extreme levity, and giving one horse-power for a weight very near that of 3·5 kilogrammes; but if we add to them the indispensable generator and the inevitable propeller, the weight increases in formidable proportions, and the system becomes inapplicable to any mode of support in the air.

Electricity, although it is better in many respects, is likewise liable to criticism. Yet we had the honor of performing some satisfactory experiments with it in 1887 at the Scientific Congress in Toulouse, and in 1888 at the Easter session of the *Société de Physique*. We had taken all possible care in the construction of a motor; it was all of aluminum, with the exception of the poles, which were of soft iron. Its weight was ninety grammes, and its power, measured with our dynamometer, was maintained at two kilogrammetres, corresponding exactly with one horse-power per 3·375 kilogrammes. This motor, armed with a light and geometrically perfect helix, made according to a new method which we had explained to the Academy of Sciences on the 12th of July, 1886, was placed in one of the plates of a balance, and put in connection with a constant electrical source of forty watts, when it raised its whole weight. In order to render more visible the extent of the result, and obtain a more exact idea of it, I arranged a light balance with long arms, to one of which I attached the motor experimented on, as in Fig. 2. The electric communications, carried through the foot, knife-edges, and arms of the balance, can not obstruct the freedom of its motion. Being movable in the vertical and horizontal directions, the balance changes immediately from the position A B to that of A′ B′. The power developed by the motor is found, by the most careful measurement, equivalent to two kilogrammes—a power so related to the weight of the motor as to be capable of raising it vertically twenty-two

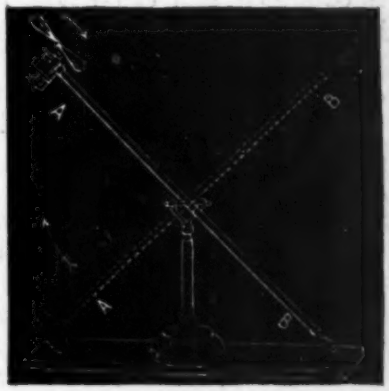

FIG. 2.—ELECTRIC HELICOPTER AND AEROPLANE.

metres in a second. The simple theoretical calculation deduced from the experimental fact assigns 3·375 kilogrammes to the motor that will develop seventy-five kilogrammes. But so minute a motor returns only about twenty per cent of the energy which is confided to it, while a motor of from fifty to one hundred horse-power will return eighty, ninety, or one hundred per cent. It is possible, therefore, and seems to be reasonable, that a large electric motor, the power of which increases faster than the weight, would employ the surplus of sixty or seventy per cent in raising the generator, the propeller, and the aëronaut. We do not intend to hypothecate the future and form tables on gratuitous suppositions, probable as they may seem. We therefore, for the moment, lay aside the electric motor, because, with its generator and propeller, it exceeds the weight of 3·5 kilogrammes per horse-power, which we have imposed upon ourselves as the minimum.

We now come to accumulators of energy. India rubber, for example, the elasticity of which is often utilized as a reservoir of power, and has a potential, in this point of view, fifteen times superior to that of steel, furnishes power and motion together. Joining to it an immediate organ of resistance to the air, we have an apparatus heavier than air. Penaud chose admirably; and one of the first helicopters was formed upon this plan. But, while India rubber stores a large sum of energy, it expends it faster than it obtains it, and can not of itself renew the provision. Penaud had only a small success with it, because the thongs he used were placed and displaced too slowly; and if he had found a means of changing them more rapidly, the considerable charge of his provision would have made him lose the primary advantages of his judicious choice.

Compressed air motors and gas motors enjoy a certain repute which is in many respects deserved; but as they are constructed, they require the assistance of lubricating and refrigerating apparatus which have weight, and are thus excluded for the present from the list of applications for aërial locomotion. So there are no steam motors, or electric motors, or accumulators of energy like India rubber, or steel, or compressed air motors or generators, that fully answer the requirements. None of them, as they are, supply such coexisting conditions of power and levity as are strictly imposed by the nature of the problem. Is it, then, true that there is now no motor with its accessories, the generator and propeller, which can be used at once, or at least improved upon, for the purpose we have in view? The comparative experiments which we have reported, and have verified with our new universal direct-reading dynamometer, which we had the honor of presenting to the Academy on the 23d of June, 1891, seem to attest this. Still, if the generator and propeller, mutually necessary,

are the organs that embarrass us, can we not find some substitute?

The electrical helicopters, with which we have obtained excellent results, seem to offer a special adaptation of the screw to the motor, which, like all electric motors, turns with an excessive velocity—so that one of the organs seems made for the other. We have often been struck, in our electric boats, with the fact that the wake at the stern is hardly perceptible. This is because the helix of our steering motor-propeller, having the great velocity of twenty-four hundred turns in a minute, enters the water as a screw its tap. In our electric helicopter, likewise, the screw forms, we might say, an integral part of the motor, thus supplying us with a motor-propeller. India rubber offers a still more perfect connection between the accumulator of potential and the motor—the generator or accumulator and the motor being absolutely identical. India rubber is a generator-motor. Hence, since we can not eliminate the generator or the propeller from the apparatus we imagine, we will absorb them and fuse them into the motor. We will create a new organism sufficing for itself, and will call it the generator-motor-propeller. We have ourself devised a propeller of this kind, by the aid of the well-known Bourdon tube, an instrument which is the essential part of the Bourdon manometers. Electricity plays in it a part only secondary, but necessary. This apparatus has so far given us satisfaction, and it may be that it will serve for some time as the essential basis of machines heavier than the air.

If the pressure of the gas contained in the tube increases, the tube changes shape, and its elliptical branches tend to spread apart; while, if the pressure is diminished, inverse action takes place, and the branches approach. If, then, we provoke a series of alternate condensations and expansions, or increasing and diminishing pressures, in the interior of the tube, it will go through a series of oscillations, of strong vibrations, capable of being used as a motor force, chiefly and perhaps only in the conditions under which we have placed ourselves. For the purpose of further increasing the energy of the resistance of the tube, and also of diminishing the volume of the chamber in which the explosions are produced, we have inclosed in the interior a similar second tube—an addition which augments the elastic force of the engendered gases, while diminishing the expenditure of combustibles. The whole of the system is represented by Fig. 1, and was presented by us to the Academy of Sciences in December, 1870.

The wings A and B are fixed directly, but with a rotary motion, at the vibrating ends of the tube, suppressing all intermediary organs of transmission by friction or rotation. Depression of the wings corresponds to condensed pressures, and elevation to dilated

pressures. The chemical combination made use of is the oxidation of hydrogen. Hydrogen is easily obtained, rapidly, in great quantities, and pure, and oxygen for burning it is already prepared in the atmosphere. Our bird, like the birds of Nature, therefore draws a considerable part of its food from the atmosphere. The detonating mixture is regulated at will, but it is nearly twenty-five parts of hydrogen to seventy-five parts of atmospheric air, while the inflammation of it is produced by electricity, as in gas machines. In the small model (Fig. 1) the generator of explosions is a revolver barrel (D), armed with twelve cartridges, the charge of which has been carefully determined; to make the catches perform and the barrel turn, the bird must be left to itself, while the cock is kept raised simply by the weight of the apparatus. To start the machine, it is suspended by a cord fixed at the end of a crane (Fig. 3), while the pendulum thus composed

FIG. 3.—ARRANGEMENTS FOR STARTING THE BIRD.

is withdrawn from the vertical and held by a second cord against the foot of the crane. Two candles, one movable (A) and the other fixed (B), placed in the verticals of the points of attachment, are intended to burn the two cords.

When we burn the first cord with the candle A, the bird, like Foucault's pendulum, begins an oscillation. It goes, describing the arc of a circle, from the position 1 to the position 2, reaching there with a horizontal velocity, when the candle B is applied and burns the suspending cord. The hammer is released and falls, the cartridge explodes, the tube vibrates strongly, and the wings falling sweep the air vigorously; at the same time the bird abandons its first horizontal position, and with its inclined tail takes on a slight movement of ascension (position 3). Thus the disengaged gases escape into the atmosphere, in the inverse direction of the move-

ment, so as to utilize their reaction. The vibrating tube resumes its original shape, and the wings rise. Promptly, the barrel, carried on by its cog-work, brings a cartridge under the hammer, which falls; a second explosion is produced, and the phenomena already described are repeated in their order. During the third, fourth, and so on to the twelfth explosion, the bird flies over a horizontal distance of seventy-five or eighty metres, sustaining itself against gravity and steadily rising. Instead of the bird falling straight down at the end of its course, the wings, kept up by the drawing together of the branches of the tube and the silken aëroplane (C, Fig. 1), the surface of which is proportioned to the weight of the imitation animal, act as a parachute, and the apparatus descends obliquely and slowly. The aëroplane, which is represented by dotted lines, connects the head of the bird with the helm, and with the wings and the tail. The use of the aëroplane will always be of advantage, whatever the power of the motor; for its surface, constantly proportionate to the total weight, will serve to prevent any accident in case of the sudden arrest of the motor machine. We repeat that, in the apparatus of large dimensions, a reservoir of compressed hydrogen is substituted for the cartridges of the small model; while the use of aluminum is suggested by its lightness and the probability of its being obtainable at a reasonable price. We also remark that the extensive cooling surface of the vibrating tube and its direct contact with the air, which will be closer as the velocity is greater, will keep it at a moderate temperature; yet there will be little danger of its getting heated, for the simplicity of the mechanism, and the removal of all transmission by rotation or sliding, will prevent the necessity of using lubricants or refrigerants. In short, the combined advantages of the generator-motor-propeller constitute it the lightest aviator that it is possible to construct. It possesses, we dare say, all the warrantees of ascensional power and return.

We shall be glad if we have succeeded in this summary in conveying to our readers the faith we have in the possibility and the near realization of practical navigation of the air; if the subject has any further interest for them, they will find a general serious and profound discussion of it in a book by M. Barral, and also full descriptions of a number of sustaining machines which we have devised, including the one we have just presented to them. Constructed during the siege of 1870, it is the first machine heavier than the air susceptible of construction on a large scale and capable of traveling by its own force. The crowning experiment in the navigation of the air now depends only on capital and secondary studies; and, again, in centering our efforts on the discovery of a strong and light motor, we believe we were the first (in 1870)

to set forth the problem correctly. We close by saying, with Victor Hugo, "The future is with navigation of the air."—*Translated for The Popular Science Monthly from Le Monde de la Science et de l'Industrie.*

THE POPULATION OF THE EARTH.

AFTER an interval of nine years the publication of the Bevölkerung der Erde has been resumed by the well-known geographical establishment of Perthes of Gotha. This is the eighth issue of this invaluable and authoritative publication. It first appeared in 1872 as a supplement to Petermann's Mitteilungen, the editors being the late Dr. Ernest Behm and Dr. Hermann Wagner, now Professor of Geography in the University of Göttingen. Up to 1882 the Bevölkerung der Erde was issued on an average every two years, always as a supplement to Petermann's Mitteilungen. While the eighth issue was being prepared Dr. Behm died, and Prof. Wagner was not able to undertake by himself the preparation of the vast mass of statistics involved. Owing to various causes, a period of nine years has elapsed before the publication has been resumed. Dr. Wagner's name still appears on the title-page as editor, associated with that of Dr. Supan, who succeeded Dr. Behm as editor of the Mitteilungen, of which the Bevölkerung continues to be a supplement. The form has, however, been changed from a quarto to a large octavo, which makes the work much handier for consultation. It covers two hundred and seventy pages, and is the one work that exhibits in detail the area and population of the earth in all its divisions and subdivisions. It is no mere indiscriminate collection of statistics. The whole is systematically arranged under the great divisions of the globe. Every figure has been critically examined; in all cases the sources of the statistics are given; where there are various figures, the value of each is discussed; where there is no authoritative census, the greatest pains have been taken to obtain trustworthy estimates. Equal care has been bestowed on the calculation of areas, new measurements of a large extent of the earth's surface having been specially undertaken for the work. Thus, it will be seen that Wagner and Supan's Bevölkerung der Erde stands high above all other works of a similar kind. The figures which it gives may be taken as the nearest approximation to the truth obtainable. It may be stated that Prof. Levasseur in 1886–'87 published in the Bulletin of the International Statistical Institute a collection of statistics on the area and population of the countries of the world, which were good and trustworthy so far as they went, though they are not nearly so detailed as those contained in the new issue of the Bevölkerung der Erde.

The preparation of the new issue has involved unusual labor, as it was necessary to examine all the statistics which have appeared since 1882. For many countries which have no censuses Dr. Supan has undertaken special investigations as to population; in this way he has dealt with Africa, Turkey in Europe and Asia, Arabia, China, East India Islands, etc. Dr. Supan is responsible for the sections dealing with Africa, America, Australia, the Oceanic Islands, and the polar regions; all colonial statistics have fallen to his share, while Prof. Wagner has looked after Europe and Asia. In several respects the arrangements of the various sections is an improvement on that of former issues.

In 1866 Behm estimated the population of the earth at 1,350,000,000. In the sixth issue (1880) of the Bevölkerung der Erde the number had apparently grown to 1,456,000,000, showing an ostensible increase of 106,000,000 in fourteen years. But this difference was really due to more accurate statistics and estimates rather than to actual growth. It was somewhat alarming, however, when in the 1882 issue the total population of the earth appeared as 1,434,000,000, showing a seeming decrease in two years of 22,000,000. But this was largely accounted for by the fact that new investigations compelled the reduction of the estimated population of China from 405,000,000 to 350,000,000. The estimate reached in the present issue of 1891 for the total population of the earth is 1,480,000,000, showing an increase of 46,000,000 over the estimate for 1882, being at the rate of 5,750,000 per annum. This estimate is 3,000,000 less than that of Levasseur in 1886, partly due to the fact that Levasseur took higher estimates of the population of China and of Africa than have Wagner and Supan. But as the data for a very large area of the inhabited globe are to a considerable extent based on guesswork, it is no wonder that estimates should differ, and that we can not be sure of the population of the world to within 50,000,000, possibly 100,000,000, either way. In 1880 Prof. Wagner found that, of the total population in that year, precise data based on actual enumeration (censuses or registration) were available for only 626,000,000 out of 1,401,000,000—that is, forty-four per cent of the total. This population has meanwhile increased to 737,000,000 (though the increase in some cases is only apparent); to this must be added 99,000,000, for which, since 1880, exact enumerations have been substituted for vague estimates. This gives 836,000,000 out of the total of 1,480,000,000 of people—i. e., between fifty-six and fifty-seven per cent—of whom fairly precise enumerations have been taken. True, in this is included 113,000,000 (the population of the Russian Empire) of whom a general census, in the modern sense of the term, has not been taken, except in the case of one or two provinces. Although, when the figures are looked at by

themselves, there has apparently been an increase of population since 1880 of 125,000,000, as a matter of fact the difference between the estimated population of 1880 (1,401,000,000, after deducting the excess credited to China) and that of 1891 (1,480,000,000) is only 79,000,000. This apparent decrease in the rate of growth is really due to the reductions which the editors have felt bound to make on the basis of more careful investigations in the estimates of the population of certain regions. Thus, they have reduced the population of Africa by 38,000,000, while in Asia a deduction of 15,000,000 has been effected. All this shows how conscientiously and critically the editors have gone about their laborious task, and leads us to place the more confidence in the results. Even in Europe there are considerable differences between the areas now accepted and those given in previous issues; the population statistics have been changed throughout.

The following table gives the area and population of the great divisions of the earth's surface according to the latest data:

	Square miles.	Population.	To 1 square mile.
Europe *	3,756,860	357,379,000	94
Asia †	17,530,686	825,954,000	47
Africa ‡	11,277,364	168,953,000	14
America *	14,801,402	121,713,000	8
Australia ‖	2,991,442	3,230,000	1
Oceanic Islands	733,120	7,420,000	10
Polar regions	1,730,810	80,400	..
Total	52,821,684	1,479,729,400	..

* Without Iceland, Nova Zembla, Atlantic islands, etc. † Without arctic islands.
‡ Without Madagascar, etc. * Without arctic regions. ‖ The continent and Tasmania.

More recent figures given in the appendix for one or two countries (British India, the Netherlands, etc.) would make no essential difference in the great total. This total is greater by over 12,000,000 than the estimate of Mr. Ravenstein in his recent paper on the Lands of the Globe still Available for European Settlement; but then Mr. Ravenstein reduces the population of Africa by about 30,000,000 below the estimate of Wagner and Supan.

Among European countries Belgium still exceeds all others in density of population; the proportion is 530 persons to a square mile. Belgium is followed by Holland, with 365 to the square mile, and the United Kingdom with 312. If we take England alone we find the density to be close on 480 to the square mile, still considerably below that of Belgium. The density in Scotland is only about one fourth that of England, while that of Ireland is one third. The most thinly populated countries in Europe are Norway and Finland, which have only sixteen people to the square mile. Turkey occupies considerable space in the

new issue, the statistics of the area and population of the various divisions and subdivisions of Turkey in Europe, Asia, and Africa, and of her tributary states, being given in minute detail, with copious references to authorities.

There are some curious and delicate estimates of the area of Europe according to various calculations and within various limits. Thus, according to Strelbitsky (who for several years has been making elaborate calculations and measurements on the subject), the area of Europe is 3,756,545 square miles, while according to Wagner's estimate it is 3,755,493, a difference of about 1,000 miles. But if to this we add Nova Zembla, Cis-Caucasia, and Cis-Uralia, the Marmora Islands, and Iceland, we get, according to Strelbitsky, 3,865,417 square miles, and according to Wagner, 3,865,279, a difference of only 138 miles. Again, if we take Europe within the limits of administrative divisions we obtain an area of 3,836,912, but this includes Iceland, Nova Zembla, the Canaries, and Madeira, making 79,165 square miles. Here comes in the question as to what are the natural boundaries of Europe, a question to which Drs. Wagner and Supan briefly refer. They regard as outside of Europe the Canaries, Madeira, the Azores, and the Marmora Islands. The inclusion or otherwise of Iceland, Spitzbergen, and Nova Zembla, will make a difference of 103,093 square miles; while there will be a further difference of 424,750 square miles depending on the limits adopted for the eastern boundary of Europe. Europe in the narrowest sense, according to these highly competent authorities, covers 3,570,030 square miles. This excludes the polar islands, and draws the boundary of eastern Europe along the crest of the Urals and the line of the Manytch River, thus excluding the Caspian Steppe, but including the Sea of Azoff. By including the polar islands another 103,000 square miles would be added. If the Caspian Steppe be included, the area of Europe would amount to 3,688,792, or with the polar islands to 3,791,792 square miles. If the boundary of eastern Europe be drawn along the Ural crest, the Ural River, and the crest of the Caucasus, we obtain an area of 3,790,504 square miles, or, including Iceland and Nova Zembla (Europe in Strelbitsky's acceptation), the area is 3,866,605 square miles. Finally, taking Europe in the widest sense, including the Ural Mountains, the south slope of the Caucasus, the countries on the east side of the Ural, and the steppe between the Ural River and the Emba, we obtain an area of 3,988,618 square miles, or, with the polar islands, about 4,092,000 square miles.

For the section dealing with Asia, Herr B. Trognitz, a land surveyor, has undertaken a new and elaborate calculation of the area of the continent on the basis of the best maps at his command. Into the details of his methods it is unnecessary to

enter; the general result is, that for the continent we are now given an area of 16,021,078 square miles, which may be slightly increased or diminished according as the boundary between Asia and Europe is drawn. To this if we add the area of all the Asiatic islands (exclusive of the new Siberian islands and Wrangel Land), we reach a total area of 17,179,490, the conclusion being that the area of Asia has hitherto been overestimated by 167,570 square miles. The total area of Asiatic Russia, according to Trognitz's calculation, is 6,510,810 square miles, not including the arctic islands. The total area of Persia is estimated at 635,165 square miles, and the estimate of population, according to Houtum-Schindler's calculation for 1882, 7,653,000, is still repeated. But taking into account that during the last nine years there have been no wars and no famines, nothing to check the natural increase of the population, competent authorities believe that the population of Persia is more likely to be about 9,000,000. Although in the body of the work the detailed population of India is only given for 1881, the authors are able, in the appendix, to give that for 1891.

There is an elaborate discussion on the subject of the population of China proper (the eighteen provinces), which at one time was greatly exaggerated, some authorities making it out to be 500,000,000. After a careful examination of all available data, Drs. Wagner and Supan are inclined to estimate the total population for China proper at only 350,000,000 in round numbers, or about 68,000,000 more than the estimate reached by Sir Richard Temple. Including Mantchuria, Mongolia, Kansu, and Thibet, the total population of the Chinese Empire is given as 361,500,000, living on an area of 4,674,420 square miles. Corea is credited with a population of 10,500,000. The total population of Arabia is reduced by Dr. Wagner to 3,472,000, very different from the estimate of 10,725,000 given by Rashid Bey in 1875. The area assigned to Arabia by Wagner and Supan is 1,153,430 square miles.

As might have been expected, considerable space is devoted to Africa, with the result that the population has been reduced to 164,000,000, whereas a few years ago a common estimate was 220,000,000. Drs. Wagner and Supan evidently consider Ravenstein's estimate of 127,000,000 much too low. They say there have been during the past few years four points of "political crystallization"—the Upper Nile, the Niger, the Congo, and South Africa. Mediterranean Africa has, as a whole, remained passive. Here are problems for the future—the fate of Egypt, the Tripoli question, and the Morocco question. A brief sketch of recent events in the partition of Africa is given, with a useful chronology from 1882 to May, 1891. To Africa south of the equator

Herr Trognitz assigns an area of 3,540,740 square miles. Of this, 951,000 square miles are assigned to British South Africa, including Nyassaland and the whole British region from the Zambesi to the Cape. The total population of this area is estimated at only 3,800,000. Neither to the Niger Protectorate nor to the British East Africa Company's sphere do Drs. Wagner and Supan venture to assign either an area or a population. The area, they tell us, is "offen" and for population they simply put a (?). To Portuguese East Africa (Mozambique) an area of 310,000 square miles is given, and Portuguese West Africa, including Portugal's share of Loanda, 517,000 square miles. The Congo Free State is credited with an area of 865,380 square miles, and a population of 14,000,000. Of the total area, 309,000 square miles are under forest.

Turning to America, we find that the Bevölkerung has not been able to secure the figures for Canada for 1891; though as a second part, containing the population of towns, will be issued, no doubt an opportunity will be taken to supplement the information given in this part. Pretty full details are given of the results of the United States census of last year.

About the rest of this invaluable collection of statistics there is nothing further to remark at present. There is a new estimate of the areas of the South American states; indeed, one of the prominent features of the new issue is the care which has been taken in estimating the area of the various states of the world and their administrative divisions. Now that Africa is divided up among European powers, whose officials are spreading all over the continent, it is to be hoped that some means will be taken to form more precise estimates of the population of the various regions. Until that is done we can not know to within millions how many people live upon the face of the earth.—*London Times.*

SKETCH OF ELIAS LOOMIS.

DURING fifty-six years of active life Prof. Loomis made original investigations and contributed valuable additions to our knowledge of terrestrial magnetism, the aurora borealis, meteoric showers, astronomy, and meteorology, and gave to students an excellent series of mathematical text-books. He was connected with four important institutions of learning, of one of which—Yale—Prof. H. A. Newton says his life and work form no mean portion of its wealth.

ELIAS LOOMIS was born August 7, 1811, at Willington, Conn., where his father—"a man possessed of considerable scholarship, of positive convictions, and of a willingness to follow at all hazards

wherever truth and duty, as he conceived them, might lead"—was pastor of a church. He grew up inclined to sedentary habits, having a taste for mathematics inherited from his father, and exhibiting a love for the languages at an age so early that he was reading with ease the New Testament in Greek at a period when many bright boys still have hard work with the reading of English. He prepared for college chiefly under the instruction of his father, spending only one winter at the academy, and was examined and admitted to Yale College at the age of fourteen, but waited, on account of his health, another year before taking his place in class. In college he took a good rank in all his studies, without showing a particularly superior proficiency in any one over another. A few weeks before his graduation, in 1830, he entered Mount Hope Institute, near Baltimore, as a teacher. Thence he went, in the fall of 1831, to Andover Theological Seminary as a student for the ministry, but was called from that vocation in May, 1833, to become a tutor in Yale College. He remained in this position till the spring of 1836, when he was appointed Professor of Mathematics and Natural Philosophy in Western Reserve College, Hudson, Ohio. Prior to entering upon the duties of this chair he spent a year in Europe attending the lectures of the distinguished French physicists of the time. He also purchased in London and Paris apparatus for use in his professorship and an outfit for a small observatory. He remained at Hudson—the college and himself being both in straitened financial condition—till 1844, when he became Professor of Mathematics and Natural Philosophy in the University of New York. He then spent one year at Princeton College in the professorship which had been vacated by the resignation of Prof. Joseph Henry to become Secretary of the Smithsonian Institution, then returned to his old place in the University of New York, and continued there till 1860, when he was elected to the professorship in Yale College made vacant by the death of Prof. Olmsted. Here he spent the remainder of his life in active service, teaching, investigating, experimenting, and publishing as long as he was able to work.

For a summary of Prof. Loomis's labors for the increase and extension of knowledge we are indebted to the memorial address of Prof. H. A. Newton, delivered before the President and Fellows of Yale College, in April, 1890, of which what follows is essentially an abridgment.

He had begun his active career before his mind seemed to incline to any one direction of study in preference to another. In childhood he was most ready in Greek; in college he was equally proficient in all his studies; at Andover he led his class in Hebrew; in his tutorship at Yale he taught Latin when he might have had mathematics. The great meteoric shower of 1833 was the sub-

ject of general conversation in the college, and he participated with much interest in the discussions that took place in the Tutors' Club over the views of Prof. Twining and Prof. Olmsted concerning the origin of the mysterious bodies. In the organization of the department committees of the Connecticut Academy of Arts and Sciences, in 1834, Mr. Loomis was assigned to that on mathematics and natural philosophy. From this time on he devoted himself predominantly to those branches of science in which he became distinguished.

He began systematic studies of the earth's magnetism during his tutorship in Yale College, setting up the variation compass of the institution in the north window of his room and making hourly observations of it, usually for seventeen hours of a single day, for thirteen months. The results of these observations—the only published American observations, except some made by Prof. Bache during ten days in 1832, that were made before 1834—were published in Silliman's Journal in 1836. He also undertook the collection of observations of magnetic declination in the United States and the construction of a magnetic chart of the country. This work was published about 1836, and in a revised second edition, with additional observations, two years later. Prof. Bache, comparing Mr. Loomis's results with those obtained by himself sixteen years later under much more favorable circumstances for exact observation and collation, declared that, when proper allowance had been made for secular changes, the agreement was remarkable. The first charts contained but few records of dip; but after removing to Western Reserve College Prof. Loomis undertook, with a dipping needle which he had procured in Europe, systematic observations of this feature. They were continued for several years at seventy stations in thirteen States, and the results were published in successive papers in the Transactions of the American Philosophical Society.

Prof. Loomis's interest in astronomy apparently dates from the meteoric shower of 1833. He read a paper on that subject before the Connecticut Academy of Arts and Sciences in October, 1834, in which he reviewed the concerted observations made by Brandes and his pupils in Germany in 1823, and deduced from them an argument in favor of the cosmic origin of the shooting stars. In November of the same year he made similar observations at New Haven in concert with Prof. Twining who was stationed near West Point, N. Y., the first observations of the kind undertaken in America.

With the new five-inch telescope, the largest then in the country, given to Yale College by Mr. Sheldon Clark, Prof. Olmsted and Mr. Loomis obtained the first sight of Halley's comet on its predicted return in 1835, and observed it throughout its course.

Mr. Loomis, with such means as were at his command, observed its place and computed its orbit. In the same year he computed, from observations of Polaris and of moon culminations, the latitude and longitude of the Athenæum tower—the longitude to within less than two seconds of the best determinations of the present.

In September, 1838, in a small observatory he had constructed at Hudson, Ohio, he began observations with the instruments—a four-inch equatorial, a transit instrument, and an astronomical clock—which he had bought in Europe. They were made upon culminations and occultations of the moon for longitude, on Polaris for latitude, and upon five comets for computations of their orbits. A sixth comet was observed by him at Hudson in 1850. These observations were of much greater relative importance in those small days of astronomy in this country, when the facilities we now enjoy did not exist, than they would be now. While Yale College had a telescope but no observatory, and the Williams College Observatory was used for instruction but not for original work, and while Lieutenant Gillis at Washington, and Mr. Bond at Dorchester, Mass., were only preparing to begin observations in connection with the Wilkes Exploring Expedition, there was, as Prof. Loomis said in his inaugural address at Hudson, in 1838, no place in the United States where astronomical observations were regularly and systematically made. A few years later the first telegraph lines had been set up, and the services of Prof. Loomis and Mr. Sears C. Walker were enlisted by Superintendent Bache, of the Coast Survey, in telegraphic determinations in 1847 and 1848—Prof. Loomis having charge of the end of the line at Jersey City and New York—of the differences of longitude of Washington, Philadelphia, New York, and Cambridge. In the next summer (1849) Prof. Loomis assisted in a similar work to connect Hudson with Eastern stations. These observations were made from three to five years before telegraphic methods were first used in Europe.

Prof. Loomis's interest in meteorology, in which his most important work was done, appears to have begun at about the same time his attention was drawn to magnetism and astronomy. He followed the discussions of the rival theories of Mr. Redfield and Prof. Espy, which began about the time of his graduation, and thenceforward made a particular study of the theory of storms. With a set of meteorological instruments bought in Europe he took complete meteorological observations twice a day at Hudson. The examination of the track of a tornado which passed near that place gave him some light respecting the course of the storm-wind and sharpened his desire to learn more about it. He next undertook the discussion of a large storm—that of

December 20, 1836—concerning which, it occurring on one of the term days which Sir John Herschel had suggested as days for a general system of observations, he was able to collect data from all parts of the United States and some stations in Canada. His discussion of this storm, in a paper read before the American Philosophical Society in March, 1840, was, Prof. Newton says, "probably more complete than that of any previous one, and the methods which he employed were better fitted to elicit the truth than any earlier methods. . . . The results which he was able to secure did not sustain either of the two rival theories, but rather tended to prove some features in each of them." The studies were continued with the examination of the track of a second tornado in February, 1842, which proved to be a part of a general storm, and of another great storm that occurred in the same month. The paper embodying the results of these observations, which was read at the centennial meeting of the American Philosophical Society, in May, 1843, is remarkable for having introduced a new method of investigation. The delineations of storms previous to the composition of this paper had attempted no more than to indicate the progress of the center of minimum pressure by lines drawn from point to point, to which a few lines were added to show certain facts about the movements of the air. "In the discussion of the storms of 1842, instead of the line of minimum depression of the barometer, Prof. Loomis drew on the map a series of lines of equal barometric pressure, or rather of equal deviations from the normal average pressure for each place. A series of maps representing the storm at successive intervals of twelve hours were thus constructed, upon each of which was drawn a line through all places where the barometer stood at its normal or average height. A second line was drawn through all places where the barometer stood two tenths of an inch below the normal," etc.; and also for places where the barometer stood above its normal height. "The deviations of the barometric pressure from the normal were thus made prominent, and all other phenomena of the storm were regarded as related to those barometric lines. A series of colors represented respectively the places where the sky was clear, where the sky was overcast, and where rain or snow was falling. A series of lines represented the places at which the temperature was at the normal, or was 10°, 20°, or 30° above the normal or below the normal. Arrows of proper direction and length represented the direction and intensity of the winds at the different stations. These successive maps for the three or four days of the storm furnished to the eye all its phenomena in a simple and most effective manner." The introduction of this method, which is the prototype, still but little improved upon, of the weather charts now in general use, is

regarded by Prof. Newton as perhaps the greatest of the services which Prof. Loomis rendered to science. The author expressed the opinion in his memoir that "if the course of investigations adopted with respect to the two storms of February, 1842, was systematically pursued we should soon have some settled principles in meteorology. If we could be furnished with two meteorological charts of the United States daily for one year—charts showing the state of the barometer, thermometer, winds, sky, etc., for every part of the country—it would settle forever the laws of storms. No false theory could stand against such an array of testimony. Such a set of maps would be worth more than all which has been hitherto done in meteorology. . . . A well-arranged system of observations spread over the country would accomplish more in one year than observations at a few isolated posts, however accurate and complete, continued till the end of time." Prof. Loomis suggested that the American Philosophical Society should undertake the supervision of such a work, for which local observers would not be wanting. The idea was seconded by Professors Bache and Peirce. The Academy of Sciences at Boston appointed a committee, of which Prof. Loomis was a member, to urge the execution of such a plan upon some proper authority. The American Philosophical Society added its voice. Prof. Henry determined to make American meteorology one of the subjects of investigation to be aided by the Smithsonian Institution; and, by his invitation, Prof. Loomis made a detailed report on the scheme, with an outlined plan of research. This plan was adopted in part by the Smithsonian Institution, but a more perfect organization of observations was needed than the institution could then command before it could reach the perfection of the present system.

In connection with a rediscussion of the storm of 1836, which Prof. Loomis undertook in 1854, he collected a series of observations made in Europe of a storm that occurred there about a week later than the one under review; but, instead of tracing a connection between them, he found that they were distinct, and that the laws of American and European storms did not agree in all cases.

Another subject in which Prof. Loomis was interested, and which stood in relation with his researches in terrestrial magnetism, was that of the aurora borealis. He collected the accounts from North America, Europe, Asia, and even the Southern Hemisphere, of the great display of August and September, 1859; and, comparing them with such facts as he could gather about other auroras, he deduced many conclusions which have since been confirmed in their essential features concerning the relations of the aurora and electricity, magnetism, light, heat, and sun-spots;

the movement of the auroral display and its correspondence with magnetic movements on the earth; the velocity of the auroral wave; the distribution of auroras over the earth's surface; their occurrence in the Southern Hemisphere; their periodicity; and other points, with the discussion of which the world has since become familiar. In these investigations and in those on other subjects Prof. Loomis was ever intent, Prof. Newton says, upon answering the questions, What are the laws of Nature? What do the phenomena teach us? "To establish laws which had been already formulated by others, but which still needed confirmation, was to him equally important with the formulation and proof of laws entirely new."

Prof. Loomis was a prolific writer. The list of his books and papers comprises one hundred and sixty-four titles upon every topic of the sciences in which he was especially interested with which he came in contact, recording the results of his experiments and their different stages. What are perhaps his most important papers were the series of Contributions to Meteorology which, beginning in April, 1874, he communicated twice a year to the National Academy of Sciences, and afterward to the American Journal of Science, in which they furnished the leading articles in eighteen volumes. In them were discussed the results of the Signal-Service observations and the subjects of European publications in meteorology. A revision of the papers was begun in 1884, on which he labored for the rest of his life, and was given to the public in three chapters, the third chapter, discussing the theory of storms, appearing in 1889. In connection with his college lectures on meteorology he published a treatise on the subject in 1868, which, "notwithstanding the rapid advances of the science during more than twenty years, is still indispensable to the student of meteorology." He published in 1850 a volume on The Recent Progress of Astronomy, especially in the United States, which went through two editions, and was then rewritten and enlarged. It was followed by the Introduction to Practical Astronomy and by popular articles in periodicals. During his connection with the University of New York he prepared a series of text-books in mathematics. The series comprised nearly twenty volumes on the subjects from arithmetic up, and, being well adapted to the requirements of teachers, has proved highly useful and successful. Not in the line of science, but a work of industry useful and interesting to all concerned, is the Loomis Genealogy, for which he made inquiries on each of his four visits to Europe, and entered into personal correspondence with every family of Loomis in the United States of which he could hear, and which grew till it contained the names of 8,686 descendants in the male and 19,000 in the female line, of Joseph Loomis, the

first American ancestor, who settled in Windsor, Conn., in 1639. Other subjects than those already specified, mentioned by Prof. Newton as those on which Prof. Loomis made experiments and published papers, were the phenomena of optical moving figures; the vibrations sent out from waterfalls as the water flows over certain dams; the orbits of the satellites of Uranus; the temperature of the planets; the variations of light of the stars η Argus and Algol; and the comet of 1861.

A striking illustration of the value of Prof. Loomis's improvement in the construction of weather maps is cited by Prof. Newton as among his recollections of conversations with Sir George Airy and Le Verrier. The former, before Prof. Loomis's maps were published, expressed himself as having little hope for the progress of meteorology in the shape in which the data then appeared. Le Verrier, exhibiting, in 1869, charts made like those of Prof. Loomis, said: "I care not for the mass of observations made in the usual form; what I want is the power and material for making such charts as these."

A description of Prof. Loomis's characteristics as a teacher is given by a biographer in the Phrenological Journal, who says: "He was a man of quick impressions and very solid convictions. A really kind man, but so strict in his views of propriety and duty that the student, as a rule, regarded him as severe. We remember him well as he appeared in the lecture-room of the university, always calm and even-toned, strict in his demands upon students who might be reciting, very brief in question, a mere trace of a smile if the student acquitted himself well, and nothing more than 'Sit down' when a student showed his ignorance of the lesson by his blundering. He was never sarcastic, never censorious. There might be a coldness of manner and a slight sharpness in his tone when annoyed, but these were passing cloudlets, so to speak, in the calm blue of his manner. He awed the frisky, mischievous ones into quiet, even well-behaved young men while they were under his penetrating eye, so that we never knew of a single instance of insubordination in his room during our course." In a description in general harmony with this, Prof. Newton includes an acknowledgment that was made by Chief-Justice Waite, that "if I have been successful in life, I owe that success to the influence of tutor Loomis more than to any other cause whatever."

CORRESPONDENCE.

THE PROGRESS OF THE SILVER QUESTION.

Editor Popular Science Monthly:

SIR: In your issue of July, 1891, the writer ventured to predict, as "a coming solution of the currency question," that a "gold clause," requiring payment of indebtedness in "gold coin of the United States of the present standard of weight and fineness," instead of silver, copper or fiat money, would be inserted in future long-time mortgages, and that (the legal validity of such clauses being unquestioned) the effect would be to decrease very greatly the then existing pressure for a depreciation of the currency. For it would become a matter of the greatest importance to any one who had obligated himself to pay in gold that no disturbance of the currency should take place which would prevent him from doing so. Various instances of importance, such as railroad mortgages, were pointed out in which financial caution had already resorted to this expedient.

It is interesting to note that this change is taking place every day. Quoting from The Honest Dollar of October 31, 1891:

"Inquiries which we have made of the most prominent companies interested in the negotiating of Western farm mortgages have been met with the invariable answer that all mortgages now placed have a clause inserted that payment shall be made in the gold coin. We have examined numerous bonds representing these mortgages, and in every case the provision that payment is to be made in gold is inserted, and thus not only respecting the principal, but also the interest, the gold clause being written or stamped upon all the coupons. This applies not only to Kansas, but to all Western and Southern States in which the farm-mortgage business has assumed large proportions. It is probable that few farmers have seriously considered the effect of this clause, and, in fact, many of them are doubtless not aware of its presence in their mortgages. Yet the matter is of immense importance to them.

"Let us consider the effect of a gold clause in connection with the theories of the silver men and their opponents, and let us take in first the statement of the silver men that the free coinage of silver would not put gold at a premium. Let us suppose, in other words, that after free coinage had been introduced the silver and gold dollars still remain of equal value. In this case the farmer has gained nothing by the free coinage of silver, and is not affected by it except in so far as all the members of the community may be benefited or injured by the change. But suppose, on the other hand, that the opinions of the anti-free-silver men are right, what is then the position of the farmer? According to this supposition the gold dollars will disappear from circulation, and be worth a premium of, say, thirty-three and a half per cent. But it is in these gold dollars that the farmer must pay his mortgage and the interest thereon—that is, he must pay in the current money one third more than the face of his mortgage. It is easy to see what this means. It means that many a farmer who is comfortably off will find himself very hard pressed, and that those who now find it hard to make the two ends meet will be utterly ruined. And this will be true even if the farmer gets somewhat more dollars for his crops, for he will not get enough more to make up for this difference, and the balance of loss will be enough to make the farmer's lot a direfully hard one. No doubt the silver men tell the farmer that the gold clause in his mortgage does not mean anything. But the meaning of the clause is perfectly clear in common sense and common justice, and a properly drawn gold clause has been held valid by the Supreme Court of the United States, from which there is no appeal. The gold clause, moreover, is part of a contract protected by the Constitution of the United States, and no State Legislature can impair its validity."

Thus the financial world is usurping the functions of statesmanship, and preparing for itself a solution of the most dangerous problem confronting this nation. In the course of a few years the great majority of long-time borrowers will be on paper having in it the gold clause, and will be aware of the fact that their chances of payment depend largely upon the maintenance of the gold standard. The political force of the movement for a cheap currency will thus be largely removed.

But there remains the law of 1890, under which 4,500,000 ounces of silver must be purchased monthly by the Secretary of the Treasury and silver certificates issued for the same. The Government buys 371¼ grains of pure silver for seventy cents and issues for it a certificate for one dollar in silver; or, what is the same thing, it buys 530 grains of silver for one dollar and issues a certificate for 371¼ grains of this as legal tender for one dollar. The force that sustains these certificates, and the silver dollars of which they are equivalents, in the market as the equivalent of the gold dollar, is the same as that which makes one tenth of a cent's worth of copper pass as one cent, or one cent's worth of nickel pass as five cents. *It is their convenience as subsidiary coin*, the impossibility of getting any other, *and the limited number in circulation*. Were the

coinage of copper free, everybody owing a dollar would buy ten cents' worth of copper, have it coined, and pay his debts with it. In this way a man owing $1,000 could pay up with $100, and pocket $900. Were the coinage of nickel free, and legal tender for the same unlimited in amount, he would buy $200 worth of nickel, pay off $1,000 of debt, and pocket $800 profit. The same thing, with diminished ratio of profit, might be looked for with the free coinage of silver.

Now the question is, How long can the Treasury issue certificates for silver without destroying the force which keeps it on a parity with gold? This depends on the amount of necessity there is for currency. The moment that the daily pressure of currency is such that a considerable portion may be conveniently withdrawn and held in safe-deposit boxes, or sent to Europe, that portion will without doubt be gold. If, then, 550,000,000 silver dollars or certificates should be suddenly put forth (that being approximately the amount of gold in circulation), gold would no doubt disappear, because business transactions are adjusted to the existing amount of currency, and the surplus amount thus made would be unavailable here, at least to a large extent. Now, how long can the silver certificates be issued without a corresponding result? Several facts are required to answer this question: 1. How great is the natural expansion of the demand for money per month? 2. How great must be the preponderance of silver before gold is hoarded in quantity? 3. When the hoarding begins, will it accelerate, from alarm or panic?

Without trying to answer these questions, upon which the best informed differ widely, it may be granted that there *is* danger in the continued issuance of so large an amount of currency based upon silver. Assuming this to be a fact, what is the probability of a modification of the law? The opponents of silver having failed for twelve years to repeal the Bland law, will they be more successful with the Sherman law?

Upon this point I hazard the suggestion that the silver movement, which seemed so dangerous a year ago, may have been a blessing in disguise. It led directly to the insertion of the gold clause in contracts, as before stated, with all the consequent effects. It led to the division of the Democratic party; to the justly famous silver letter of ex-President Cleveland; to the defeat of Governor Campbell in Ohio; and to the necessity of choosing an Eastern man, or one opposed to any form of fiat money, for the presidential nominee of the Democratic party. Thus the recoil from the silver agitation has far exceeded in importance of effect the original momentum. The continuous effect of the "gold clause" goes marching on to an irresistible issue in a stable single standard; and it would not be surprising if the final result of the silver movement of the past year would be the relief of the country from the dangers of the compromise law made in the fury of the recent silver agitation.

CHARLES S. ASHLEY.

COLORS OF NAMES.

Editor Popular Science Monthly:

SIR: An article in a recent number of The Popular Science Monthly, by President D. S. Jordan, on The Colors of Letters, assigning colors more or less pronounced to the different letters of the alphabet, reminds me of a childish fancy of my own, of which I have often thought, but to which I had never before attached any significance. The days of the week were as distinctly marked or colored in my early conception as the objects about me. Sunday was red; Monday a light pink; Tuesday gray, with irregular streaks of a darker hue; Wednesday was green, with interstices of a dull white; Thursday was yellow, but not of deep tone; Friday was pink again, and of deeper tinge than Monday; and Saturday was green. What is there in these names to suggest colors? The associations of the days do not seem to offer any explanation, with possibly one or two exceptions, and, if it be a mere freak of imagination, it would be interesting to know the experience of others touching the same matter. Again, as I think over the names of the months and the seasons now, there is a suggestion of color in each, but more, I think, the result of association than in the days of the week.

J. H. CHAPIN.

ST. LAWRENCE UNIVERSITY, CANTON, N. Y., *November*, 1891.

EDITOR'S TABLE.

EVOLUTION AND ITS ASSAILANTS.

THE doctrine of evolution teaches that the changes which take place in the universe both of mind and matter follow an orderly sequence, and that each preceding stage potentially contains the succeeding one—that every succeeding change can only be explained and understood through a comprehension of the preceding one. It incites us, therefore, to a study of cause and effect, and encourages us to believe in the possibility of a rational interpretation of Nature. Strictly speaking, evolution is nothing more than a generalization of the idea of cause. Every man within

certain limits is an evolutionist, and we have little hesitation in saying that the limits within which each man is an evolutionist are the real limits of his intelligence. Where he ceases to be an evolutionist he resigns all attempt to comprehend, and merely records his acceptance of unexplained facts. In the sphere of human history the principle of evolution seems to be fully recognized. The historian who would fold his hands and turn up his eyes before any given event, and say that it was utterly incomprehensible, having no relation, save the abstract one of time, to previous or subsequent events, would be scorned by every intelligent reader. Not to be able fully to explain a historical occurrence is one thing; to say that it has no dependence on previous conditions is another and very different thing. We look to the historian to attack such problems with a view to bringing them under the operation of some law of historical development; in other words, we believe fully in evolution as applied to the social and political history of mankind.

Similarly we believe—and when we say "we" we mean all persons with any pretensions to education or intelligence—in evolution as applied to the physical history of our globe. We believe that it passed through successive stages or phases, each of which prepared the way for the one following. "Evolution," says Prof. Le Conte, "is the central idea of geology. It is this idea alone which makes geology a distinct science. This is the cohesive principle which unites and gives cohesion to all the scattered facts of geology; which cements what would otherwise be a mere incoherent pile of rubbish into a solid and substantial edifice."* That the Silurian age passed naturally into the Devonian, which served as a transition to the Carboniferous, no one who has given any thought to the subject for a moment doubts. The trouble arises when it is proposed to consider successive animal species as genetically connected. The scientific world at large has no difficulty in framing the conception or in adopting the idea, but to a few scientific men and a multitude of non-scientific persons there is impiety in the suggestion that one animal species —or one plant species, for that matter— could possibly have passed into or given birth to another. The creation of species was an office which their theology had reserved for a supernatural being, and they can not assign to natural causes or processes the honor of introducing to existence so much as the tiniest parasite. Whatever is most hideous, uncouth, destructive, and loathsome in the animal kingdom must be regarded as the special and intentional production of Divine Wisdom no less than the noblest forms of life. None the less do men set themselves to destroy whatever in creation they find hurtful or inconvenient; in practically dealing with plants and animals they ask—not, "Did Divine Wisdom create it for a wise purpose?" but, "Does it suit our interests to allow it to exist?"

The great weakness of the assailants of evolution is that they do not offer so much as the germ of an instructive or helpful idea in the place of that which they oppose and would fain subvert. Admitting that there has been much of error in connection with the speculations of the evolutionist school, the error, we contend, has been of a healthful kind. An ancient Greek philosopher held that what was of chief importance in a scientific theory was, not that it should be in exact accordance with facts, but that it should be based on belief in a natural sequence of phenomena. Anything, he said, rather than the non-natural, the irrational, the arbitrary— in a word, anything rather than superstition. And he was right; for the man who is taught to believe in natural causes, studies natural causes; and if,

* Elements of Geology, p. 405.

at a given moment, he attributes to them wrong effects, his further observations will in due time cure him of his error. Thus the errors of the evolutionists are sure to be discovered and corrected, for they consist, and can consist, only in wrong suppositions as to the relations between material phenomena—phenomena which are open to the study of all, and which have no habit of hiding themselves behind a veil of mystery. But what remedy is there for the errors of superstition? What can we say to the man who believes in the uncaused, to whom the universe is full of facts that bear on them no stamp save that of arbitrary will? His superstition is a pillar round which reason will chase him in vain.

To say that every vegetable and animal species is the special result of a distinct divine fiat is to put a veto upon all scientific inquiry in the region of biology. But to-day such a veto comes too late. The world has learned too much under the guidance of the doctrine of evolution, too many regions of knowledge have been fertilized by it, too many individual minds have found in it a never-failing spring of instruction and intellectual stimulation, for any overthrow, or even any obscuration, of the idea to be possible. What, we ask, have its opponents to teach? They are compelled to recognize the general principle of evolution in history, geology, and many other fields of research, and, so far as they do, their intelligence has free scope. But what do they teach instead of it in the field of biology? Absolutely nothing. They simply draw a line and say, "Here begin wonder, miracle, mystery, all that is arbitrary and thought-confounding." To the opponent of evolution the resemblances, analogies, and homologies that run through animated nature are simply so many false lights, *ignes fatui*, suggesting community of origin where community of origin there is none. Rudimentary organs signify nothing, neither do the facts of embryology. All that can be said is that God made things as they are, rudimentary organs and all, just as suited himself. If different species and genera show resemblances, it is simply because the same ideas kept running through the Divine Mind. Such is the sum and substance of anti-evolutionist teaching. That it is anti-scientific, and that it tends to nothing less than paralysis of the intellectual powers, is evident at a glance. Fortunately, it is confined nowadays to synods and conferences, and even there is not received with entire favor. At the recent Œcumenical gathering of Methodists at Washington an earnest divine from the Southern States found some of his brethren, particularly those from England, badly infected with evolutionary ideas. A similar discovery might be made in almost any similar assembly to-day. Evolutionists may therefore proceed very contentedly with their studies. They are in the right path, because they believe in the universality of natural causation; and, if they fall into error, they will work their way out again without any abandonment of their cardinal principle.

LITERARY NOTICES.

THE HISTORY OF HUMAN MARRIAGE. By EDWARD WESTERMARCK. London and New York: Macmillan & Co. Pp. 644. Price, $4.

THE words of Pope—"The noblest study of mankind is man"—long used as a motto by the cultivators of the so-called humanities, are in full agreement with the disposition of scientific research to give increasing attention to the field of anthropology. Folk lore, family and tribal customs, the evolution of religions, the origin and development of races, heredity, etc., are pre-eminently the scientific topics of the time. The many who are interested in this department of science will welcome the work of Dr. Westermarck, concerning which A. R. Wallace says in an introductory note, "I have seldom read a more thorough or a more philosophic discussion of some of the most difficult and at the

same time interesting problems of anthropology." The author defines marriage as a more or less durable connection between male and female, lasting till after the birth of the offspring. The lowest animals among which traces of such a connection are found are the turtles. With the birds it is an almost universal institution, while among the mammals it is restricted to certain species. In the lower animals reproduction is timed with reference to the season of plentiful food-supply, and, as there are seasons of plenty and scarcity of the food of man, the author believes that in primitive times there was a human pairing season. Some of the lowest races actually have such a season at the present time, and certain peoples of a little higher grade have yearly nuptial festivals, while in civilized countries it has been found that more children were born at one or two periods in the year than at other times. The view that primitive men and women lived in promiscuous sexual relations is opposed by Dr. Westermarck, who sees no ground for this hypothesis in the customs of uncivilized tribes of the present time. Passing on to the mode of contracting marriage, the author gives a wealth of information concerning customs of courtship among various peoples and also concerning the related subjects of means of attraction and the liberty of choice. By a chapter on sexual selection among animals he leads up to a consideration of the same process in the human species, his treatment of this subject being one of the points to which Mr. Wallace calls especial attention in the introduction The author maintains that man in the choice of a mate prefers the best representatives of his particular race because a full development of racial characters indicates health, while a deviation from them indicates disease. The production of the instinct which esteems beauty above ugliness is ascribed to natural selection. "According to Mr. Darwin," says Dr. Westermarck, "racial differences are due to the different standards of beauty, whereas, according to the theory here indicated, the different standards of beauty are due to racial differences." The prohibition of marriage between kindred is almost universal, but, as our author shows, all sorts of differences exist as to the unions that are regarded as incestuous by different peoples. His study of this matter has brought him to the conclusion that it is not the relationship but living in the same household that causes the repugnance to marriage between kindred, and that this feeling by no means results from observed bad effects of in-breeding. Among the other subjects examined in this work are marriage by capture and marriage by purchase, marriage-rites, polyandry, polygyny, and divorce. A copious list of authorities quoted and an excellent index are appended. The treatise is marked throughout by evidences of thorough study, clear insight, and sound reasoning.

INTERNATIONAL EDUCATION SERIES, VOLUME XVIII.

A TEXT-BOOK IN PSYCHOLOGY. By JOHANN FRIEDRICH HERBART. Translated by MARGARET K. SMITH. New York: D. Appleton & Co. Pp. 200. Price, $1.

THE work of Herbart now presented to English readers in a translation from the revised edition of 1834 is described by the author as "an attempt to found the science of psychology on experience, metaphysics, and mathematics." For a quarter of a century, beginning in 1809, Herbart occupied the chair at the University of Königsberg that had previously been filled by the celebrated Kant. In directing a pedagogical seminary, or normal school, which he founded, he applied philosophy to the art of education. The central thought of the present treatise, as is pointed out by Dr. Harris in the editor's preface, concerns the act of apperception. The book thus constitutes a sequel to the writings of Pestalozzi. For, while Pestalozzianism enforces the importance of perceiving fully and accurately by the senses what is to be learned, the Herbartian pedagogics is occupied mainly with the second step in the learning process—the recognizing of what is perceived as identical with or similar to something that has been perceived before. An impression stored in the mind by a former experience may be out of consciousness at a given moment, but may be brought up into consciousness by some kindred idea. Herbart's theory concerning these phenomena represents ideas as connected in groups, and the forces with which they interact upon each other he represents by mathematical formulas.

The foregoing are among the funda-

mental principles included in the first division of the volume. The second division deals with the so-called mental faculties and with mental conditions, being analytical and descriptive in character. This he calls Empirical Psychology. There is a third part entitled Rational Psychology, treating of the relations between the soul and matter, and giving explanations of various psychological phenomena. "To the mere reader of psychology," says the translator in her introduction, "the Herbartian theories may at first appear peculiar, and in the minds of some may verge upon the absurd; but the careful student will probably find no psychological theories that are so well calculated to stand the test of actual experience."

A Handbook of Industrial Organic Chemistry. By Samuel P. Sadtler. Philadelphia: J. B. Lippincott Co. Pp. 519. Price, $5.

The aim of this work is to give a general view of the various industries based upon the applications of chemistry to the arts. The mode of procedure in dealing with each industry is "first to enumerate and describe the raw materials which serve as the basis of the industrial treatment; second, the processes of manufacture are given in outline and explained; third, the products, both intermediate and final, are characterized and their composition illustrated in many cases by tables of analyses; fourth, the most important analytical tests and methods are given, which seem to be of value either in the control of the processes of manufacture or in determining the purity of the product; and, fifth, the bibliography and statistics of each industry are given, so that an idea of the present development and relative importance of the industry may be had." To assist the reader in following out the chain of operations that converts the raw materials into the various finished products and by-products, a diagram something like a genealogical tree is given in many cases. One such diagram shows at a glance the processes involved in working up beef-tallow, and how much of each product is obtained from the proximate yield of one ox. Another diagram shows how thoroughly the cotton seed is now utilized. Three chapters are devoted to the oils—petroleum, the fats, and the essential oils; the sugar industry is next described; then come the industries of starch and its alteration products, fermentation industries—including the making of alcoholic liquors, vinegar, and bread—milk industries, the utilization of vegetable and animal fibers; the preparation of leather, glue, and gelatin; industries based upon the destructive distillation of wood and coal, the making of dyes, and dyeing. The machinery and apparatus used in each industry are described, and the text is illustrated with one hundred and twenty-seven figures. While the book deals mainly with the chemical changes involved in the industries described, its language has been so chosen that those not specially trained in chemistry can readily understand it. An appendix contains temperature, specific gravity, and alcohol tables, also metric weights and measures.

Stones for Building and Decoration. By George P. Merrill. New York: John Wiley & Sons. Pp. 453. Price, $5.

This work is designed to be of service to all who have to do with the use of stone for constructive purposes. It tells what resources of building-stone are known in each State of the Union, what is the character of each kind and variety, how each works, methods of quarrying and dressing stone, cost, durability, weathering, etc. The book is based on the author's hand-book and catalogue of the collection of building and ornamental stones in the United States National Museum, and some of the matter not contained in that hand-book has been published in various building-journals. The author's experience in preparing the extensive collection above mentioned, as well as its partial duplicate at the American Museum in New York, has afforded him ample opportunity for becoming acquainted with the quarry products of the country at large, while extensive field trips, particularly in the eastern and extreme Western United States, have given him a practical insight into the resources of these regions, as well as some knowledge concerning the usual methods of quarrying and working. The volume is illustrated with views of quarries, figures of tools and machines used in quarrying and working stone, figures showing kinds of finish on stone, and the microscopic structure of certain rocks, etc.

MIND IS MATTER; OR, THE SUBSTANCE OF THE SOUL. By WILLIAM HEMSTREET. New York: Fowler & Wells Co. Pp. 252.

IT is impossible to concur with this author even in his presentation of physical truth, and this naturally hinders serious consideration of his views upon such impalpable matters as "astral fluid," "odic force," or "the atomicity of God." His purpose is high and earnest—to win men from grossly material pursuits to a more spiritual life. This he hopes may be realized through his philosophy, that God and the soul are material existences. "God with us—not as a conjecture nor metaphor, but a chemical fact—is all there is of religion." He seeks to establish his theory of soul as a substance "by scientific methods" and with "facts that we all agree about." The most pertinent of these "facts" prove to be the phenomena of personal magnetism and coincidences of thought, in regard to which there is scarcely any agreement of opinion. Other extraordinary assertions are—"force is a *thing* in motion," "all matter is reducible to electric atoms," "electricity or nerve-fluid is the latest discovery in physiology," "every unit of matter must have a sex." The statement is also made that the amœbæ do not eat. The biological truth is that an amœba incloses any vagrant diatom by its pseudopods, ingests it, and assimilates it as actually as higher organisms digest their special food. The amœbæ are even particular in their diet and do not feed upon starch or fat, so that there is no necessity whatever for the "direct conversion of existing atomicity into living things." There is no doubt, "if we could learn by science and philosophy the simple, natural fact that our personal existence is continuous, it would entirely change human life and society," but, speaking scientifically, the "if" exhibits as yet no sign of katabolism.

THE HISTORY OF COMMERCE IN EUROPE. By H. DEB. GIBBINS. London and New York: Macmillan & Co. Pp. 233. Price, 90 cents.

THIS short work is believed by the author to be the first attempt in English to present a connected account of the progress and development of commerce in Europe from antiquity to the present time. In the space to which the book is limited only the main outlines of the subject could be given, but they are enough to convey an idea of the course of development, and to furnish a sketch which may at some future time be more adequately filled up. The history is given under the three heads of Ancient and Classical Commerce, Mediæval Commerce, and Modern Commerce, the last including the history of the commercial empires in the East and in the West; English commerce in three periods—from the sixteenth to the eighteenth century, the industrial revolution in England and the continental war, and modern English commerce; France and Germany; and Holland, Russia, and the other States of Modern Europe. The commerce of the United States does not properly come within the scope of the work, except as in its relations to the European nations. References are made in several places to the trade with the colonies, and to the later trade with the States. And, under the heading, Recent Developments of Commercial Policy, the "insane example of America" and the "notorious McKinley tariff" are mentioned as patterns which European countries seem inclined to follow; and we are warned that, although we can not understand it, both Europe and the United States may in time discover the fact "that freedom of trade and industry, even though it may seem to encourage foreign competition, is nevertheless of inestimable advantage to the country that adopts it. . . . Meanwhile, both in her colonial policy and in her system of trade and industry, England, though she has yet much to learn, is setting an example to all European nations."

CATALOGUE OF MINERALS AND SYNONYMS. By T. EGLESTON. New York: John Wiley & Sons. Pp. 378.

THE author began a catalogue in 1867 for use in arranging the collections of the School of Mines of Columbia College, but was interrupted in the work. When he came to resume it, in 1885, he found that the progress of the science had been so great that the whole had to be done over again from the beginning. The study of mineralogy is embarrassed by the great varieties of synonyms that prevail for the same mineral, whether in different languages or in the works of different authors. The object of the present cat-

alogue appears to be to remedy this difficulty by giving all the synonyms for each species under the head of the authorized English name, and by cross-references. The names of species are printed in capitals, those of doubtful species in italics, and those of synonyms in ordinary type; and the name of the authority for the species is given, as far as possible, in italics. Well-authenticated species are printed in large capitals; the synonyms follow in alphabetical order; and under species important varieties are printed in small capitals, with their synonyms. The synonyms under each species are divided into classes where that is necessary, and then arranged alphabetically for convenience in referring to them. The symbols representing the composition of the minerals are given according to the new system. The catalogue meets a felt want, for none of the standard works on mineralogy has a complete index.

INTIMATIONS OF ETERNAL LIFE. By CAROLINE C. LEIGHTON. Boston: Lee & Shepard. Pp. 139.

THE worthy aim of this little book as defined in its preface is, "to elicit something clear and trustworthy" in regard to the effect of scientific discovery upon the probabilities of a future life. The author considers that science has been misinterpreted, especially concerning "the existence of God, the reality of the soul and its independence of the physical brain," and she proceeds to liberate it from misconception. The actuality of things unseen is evinced by the invisible rays of light, sounds made audible by the microphone, the phenomena of radiant heat, and molecular motion. The indestructibility of matter and the conservation of energy give reassurance of transformation, while the all-pervading, luminiferous ether "makes the universe seem one and homelike"! Within closer limits two uses are found for this ether: one as material upon which memory impressions may be made; the other, as the substance of the psychic body. Nature hints at continuance in the resurrection of the spring-time, and the fragmentary character of human life implies future completion, which, it is represented, may take place in other worlds than ours. We may yet remain "in the stream of evolution" and find an abiding-place without question of room, for, "if the planets fail us, there are all the hosts of the fixed stars." The nature of death and disposal of the dead are discussed, and cheerful views of our departure from earth are urged. Authorities are given with great impartiality from Prof. Tyndall to the Tonga Islanders, and science, like a veritable Sindbad, is made to sustain a multitude of inferences. Altogether, it must be said, this search for scientific confirmation of the hope of a hereafter is more suggestive than satisfying.

THE METAL-WORKER ESSAYS ON HOUSE-HEATING BY STEAM, HOT WATER, AND HOT AIR. Arranged by A. O. KITTREDGE. New York: David Williams. Pp. 288. Price, $2.50.

THE essays in this book were prepared in 1888 in answer to an offer of prizes by the periodical, The Metal-Worker, for the best methods of heating a house, plans and elevations of which were given. Three systems of heating—by steam circulation, by hot-water circulation, and by hot air—were recognized in the competitions; and provision was made for the consideration of combination plans. The results of the competition were very successful, both in the number and character of the essays received and the attention they attracted. The essays in this book are reprinted from the journal in which they were first published; and to them are added summaries derived from very careful study of the competitive efforts. The papers are arranged under four different heads, namely: 1. Combination Systems, two essays—one on Steam and Warm Air, and one on Hot Water and Hot Air. 2. Steam-heating Systems, four essays. 3. Hot-water Circulating Systems, three essays. And 4. Hot-air Systems, six essays. The papers indicate wide ranges of practice; and it is believed that, taken altogether, the fifteen essays present a better idea of current practice in house-heating than can be found anywhere else. All the systems proposed are adequately illustrated.

SECOND ANNUAL REPORT OF THE GEOLOGICAL SURVEY OF TEXAS, 1890. E. T. DUMBLE, State Geologist. Austin. Pp. cix + 756.

THIS large volume is devoted mainly to describing the mineral resources of the

State so far as determined during the two years' existence of the survey. In the course of the second year the co-operation of the United States Geological Survey and of the United States Coast and Geodetic Survey were secured in topographical work, much to the advantage of all branches of the work of the State Survey. Several geologists worked during the year at mapping the iron ores of the east Texas district, and the associated clays and lignites were also studied. Prof. Robert T. Hill studied the economic geology of the Cretaceous area, but resigned from the survey without making his report. Prof. W. F. Cummins was engaged in a detailed study of the coal measures of the central coal field; the Guadalupe Mountains were explored by Mr. Tarr; and further work on the mineral resources of central Texas was done by Dr. T. B. Comstock, who discovered tin in this region and obtained much information concerning the deposits of other metals, and of granite and salt. In the trans-Pecos region, Prof. W. H. Streeruwitz, after completing the topographic mapping of an important area, spent the rest of the season in examining the mineral veins of the region. For lack of books and type specimens most of the paleontological work on the Texas rocks has been done outside the State. An offer by the State Geologist to furnish collections of the rocks and minerals of Texas to the high schools of the State brought more applications than could be filled; forty-one sets, more or less complete, were furnished. The details of the year's work are given in the papers accompanying the report of Prof. Dumble, the text being illustrated with maps of the several localities, drawings of sections, and photographic views.

AN INTRODUCTION TO THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. By W. T. A. EMTAGE. New York: Macmillan & Co. Pp. 228. Price, $1.90.

THIS work, which appears in the Clarendon Press Series, is adapted to students far enough advanced to possess a knowledge of differential and integral calculus. It is complete in itself, and may be read without previous knowledge of the subject. Purely experimental parts of the subject requiring no special mathematical treatment have been entirely omitted.

PLANE AND SOLID GEOMETRY. By SETH T. STEWART. New York: American Book Company. Pp. 406. Price, $1.12.

PROMINENT features of this text-book are its strict adherence to the principle of association and its graded exercises. Each book treats of one subject, and each section treats of one subdivision of the subject, so that all relating to the subject or its subdivisions being placed together, the several parts will support one another in memory by the law of association. The same method of arrangement—the resultant form of the book being one that is rendered possible only by the grouping of propositions—favors the regular gradation of exercises. At the end of each section miscellaneous exercises, assorted and graded, are presented in an order intended to promote, by their successive solution, a constant growth in the power of analytic and synthetic thought. A synopsis of each book precedes the book itself, as an encouragement to students to work independently of the demonstrations given in the text. Thus, before giving the definitions of points, lines, and angles, the pupil is set to construct them if we may use the word, after which the definition follows, of necessity; and so on, through the book. The inductive method is in this way employed in the treatment of each part of the work; but, while the approaches to the subject are thereby rendered more agreeable, the author has been conservative in retaining, as far as possible, the usual phraseology of propositions and a wholesome rigor in demonstration. Throughout the volume the diagrams and demonstrations are in full view of each other.

No. 3, Vol. IV, of *The Journal of Morphology*, contains seven papers. The first embodies some *Studies on Cephalopods*, in regard to Cleavage of the Ovum, by *S. Watase*. It is illustrated with four plates and nineteen figures in the text. *J. Playfair McMurrich* has a second installment of his *Contributions on the Morphology of the Actinozoa* in this number, dealing with the Development of the Hexactinia. It is accompanied by a plate. There are short papers by *G. Baur* on *Intercalation of Vertebræ*, and by *W. M. Wheeler* on *Neuroblasts in the Arthropod Embryo*. *G. Baur* also contributes a paper on *The Pelvis of*

the Testudinata, with notes on the evolution of the pelvis in general. *Prof. C. O. Whitman* has two papers in this number, one dealing with *Spermatophores as a Means of Hypodermic Impregnation*, the other being a *Description of Clepsine Plana*. Each is accompanied by a plate.

The most extended paper in No. 1 of Vol. V is by *W. B. Scott*, of Princeton, on *The Osteology of Poebrotherium*. This number contains also *A Contribution to the Morphology of the Vertebrate Head, based on a Study of Acanthias vulgaris*, by *Julia B. Platt;* a short paper on the *Reproductive Organs of Diopatra*, by *E. A. Andrews;* the third of Dr. *McMurrich's* series, dealing with *The Phylogeny of the Actinozoa;* and an account of the *Development of the Lesser Peritoneal Cavity in Birds and Mammals*, by *F. Mall*. Plates and small figures accompany the papers.

An address to the New England Cremation Society by its president, Mr. *John Storer Cobb*, has been printed in pamphlet form, with the title *The Torch and the Tomb*. Mr. Cobb cites many instances in which the decomposition of buried bodies has caused disease by polluting water-supplies, by contaminating the air that passes over cemeteries, or by allowing the escape of bacteria into the overlying soil in cases of deaths from infectious disease. He also shows the lack of foundation for the current objections to cremation, and quotes the enthusiastic approval of this process expressed by a clergyman whose prejudice had been completely removed by witnessing the incineration of a friend's remains. The society was organized in January, 1891, and Dr. W. H. Wescott, P. O. box 2,436, Boston, is its general secretary.

The Archæological Institute of America has published *Contributions to the History of the Southwestern Portion of the United States*, by *A. F. Bandelier*, one of the archæologists of the Hemenway Expedition. These papers embody materials derived from the archives of Santa Fé, Santa Clara, El Paso del Norte, and Mexico, together with topographical and archæological data obtained by exploration. A preliminary sketch is given of the knowledge which the Spaniards in Mexico possessed of the countries north of the province of New Galicia previous to the return of Cabeza de Vaca, in 1536. This is followed by four monographs, dealing respectively with the wanderings of De Vaca; Spanish efforts to penetrate to the north of Sinaloa, between 1536 and 1539; Fray Marcos of Nizza; and the expedition of Pedro de Villazur from Santa Fé to the Platte River in 1720. A subscription of one thousand dollars is solicited to complete the final report of Mr. Bandelier on his investigations among the Indians of the Southwest.

The Third Year-book of the Brooklyn Institute, 1890–'91, gives evidence of renewed vigor in this old institution. The book contains lists of officers and members, the by-laws, a brief history of the Institute, and an account of the work of 1890–'91. During the past winter each of the many departments of the Institute provided a lecture once a month, making a large aggregate of such lectures. The library of the Institute comprises 13,000 volumes, and its circulation for the year ending September 1, 1890, was 55,891. A biological laboratory course was carried on during July and August, 1891, at Cold Spring Harbor, Long Island, under the direction of Prof. H. W. Conn. In December, 1888, a movement for the formation of Museums of Art and Science in Brooklyn was initiated by the Institute, and considerable progress has been made in this direction.

The principle of the slide-rule has been applied by Mr. *H. J. Thomas* in the *Slide-Rule Perpetual Calendar* (Jerome-Thomas Co., New York, 25 cents). This calendar can be set for any month of any year, past or future, and old style as well as new style. We note one misprint—29 for 59—in the Year Letter Table.

An essay from the pen of *Edward L. Anderson*, sketching the origin and development of man, has been sent us (R. Clarke & Co., 25 cents). It is untechnical in language and highly finished as to literary style. The author entitles the essay *The Universality of Man's Appearance and Primitive Man*, and affirms his conviction that man "appeared everywhere upon the earth, where the conditions were favorable, during a certain geological period." He also asserts that man has a soul, and that a pure soul is worthy of immortality.

The *Report of the New York Agricultural Experiment Station*, for 1890, records the

beginning of feeding experiments with milch-cows, for which extensive preparations had been made, also feeding experiments with poultry and swine, and tests of various sorghums. Considerable analytical work on a variety of substances had been done by the chemist; the horticulturist reports tests of a number of vegetables and small fruits; the pomologist describes his researches of the year on the grape and the peach; and a variety of operations are embraced in the report of the farm superintendent.

Mr. *James Terry*, of the American Museum of Natural History, New York, has published a monograph on three *Sculptured Anthropoid Ape Heads* found in the valley of the Columbia River. These heads were carved from a dark pumiceous, basaltic rock; and the author regards as the most probable conclusion concerning their origin "either that the animals which these carvings represent once existed in the Columbia Valley, or that, in the remote past, a migration of natives from some region containing these monkeys reached this valley, and left one of the vivid impressions of their former surroundings in these imperishable sculptures." Five artotype plates accompany the text.

A handsomely printed monograph of one hundred and fifty-six quarto pages, entitled *Dynamics of the Sun*, has been published by *J. Woodbridge Davis* (D. Van Nostrand Co., New York). It is a mathematical and theoretical essay dedicated to the astronomers, and they alone will be able to appreciate it.

A Chart of the Metric System, published by the American Metrological Society, contains tables of the measures of length, area, capacity, and weight; definitions of the terms used in the system; equivalents of cubic measures and weights, and exact-sized diagrams of the metre, the metre graduated into decimetres, centimetres, and millimetres: the litre; the cubic centimetre; ten cubic centimetres; one hundred cubic centimetres; the cubic decimetre; and the kilogramme weight; the whole covering a sheet suitable to hang on the wall. On the back are printed facts concerning the metric system; the action of various nations and of the United States adopting or recognizing it; the adaptation of the metric units to various scales of plans; metric equivalents of old units; graphical conversion and official abbreviations; the metric system in government business; its adaptation to the United States land system; metric railway curves; and other information.

The third volume of Dr. *McCook's American Spiders and their Spinning-work* will be ready for delivery in the coming spring. The cost of preparing the numerous engravings and plates has so greatly exceeded the expectations of the author (who is also the publisher) that he feels constrained to raise the price to new subscribers from $30 to $50 the set.

PUBLICATIONS RECEIVED.

Abbott, Francis Ellingwood. Appeal to the Corporation and Overseers of Harvard University. Pp. 48.

Atkinson, Rev. J. C. The Last of the Giant-Killers. Macmillan. Pp. 244. $1.25.

Bien, H. M. Ben Beor. A Story of the Anti-Messiah. Baltimore: Isaac Friedenwald & Co. Pp. 528.

Bolles, Frank. Land of the Lingering Snow. Houghton, Mifflin & Co. Pp. 230. $1.25.

Brooklyn Ethical Association. Season of 1891-'92. Pp. 50.

The Californian Illustrated Magazine. No. 1, Vol. I. San Francisco. Pp. 114. 25 cents, $3 a year.

Chamberlain, A. F. Modern Languages and Classics in America and Europe since 1880. Toronto, Ont. Pp. 60.

Chambers, George. Pictorial Astronomy. Macmillan & Co. Pp. 263. $1.

Clay, Cassius Marcellus. Oration before the Maumee Valley Historical and Monumental Association. Toledo, O. Pp. 19.

Denton, Prof. J. E. Trap-siphonage and Trap-seal Protection. Concord, N. H. Pp. 56.

Experiments in Physical Science. Pp. 59.

Foote, A. E. A New Locality for Meteoric Iron, and Diamonds in the Iron. Pp. 6, with Plate.

Foster, Dr. M. A Text-Book of Physiology. Part IV. Macmillan & Co. Pp. 415. $2.

Gage, Simon Henry. The Microscope and Histology. Ithaca, N. Y. Pp. 96.

George, Henry. The Condition of Labor. An Open Letter to Pope Leo XIII. New York: United States Book Company. Pp. 157. 80 cents.

Gould, George M., M. D. Fifteen Hundred Cases of Refraction (in Eyes). Pp. 36.

Greely, A. W. Temperature Charts by Decades. For the United States and Canada. Washington: Signal Office. Seventy-two Charts.

Griswold, W. M. A Descriptive List of British Novels. Cambridge, Mass. Pp. 200.

Hellyer, S. Stevens. Principles and Practice of Plumbing. Macmillan & Co. Pp. 294. $1.25.

Herbart, Johann Friedrich. A Text-Book in Psychology. New York: D. Appleton & Co. Pp. 200. $1.

Hermetic Philosophy. Vol. II. J. B. Lippincott Co. Pp. 310. $1.50.

Huxley, T. H. Les Sciences Naturelles et l'Éducation. Paris: J. Baillière et Fils. Pp. 360. 3 *fr.* 50.

James, Prof. Joseph F. Age of the Point Pleasant (Ohio) Beds. Pp. 10, with Plates.

Keen, W. W., M. D. Compressing the Subclavian

Artery. Pp. 3.—A New Method of Tenotomy. Pp., 5.—Four Operations for Appendicitis. Pp. 6.

Lang, Dr. Arnold. Text-Book of Comparative Anatomy. Macmillan. Pp. 562. $5.50.

MacDonald, M. Report of the Commissioner of Fish and Fisheries for 1887. Government Printing-office. Pp. 899.

Mackay, John Henry. The Anarchists. Boston: Benjamin R. Tucker. Pp. 305. 50 cents.

Manson, Marsden. The Cause of the Glacial Period, etc. San Francisco. Pp. 21.

Maynard, Mrs. N. C. Was Abraham Lincoln a Spiritualist? Philadelphia: R. C. Hartranft. Pp. 264. $1.50.

Means, James. Mantlight. Boston. Pp. 29.

Michigan Mining School, Houghton, Mich. Catalogue. 1890-'91. Pp. 102.

Mills, Wesley. How to keep a Dog in the City. New York: W. R. Jenkins. Pp. 40. 25 cents.

Missouri Botanical Garden. Announcement concerning Garden Pupils. Pp. 8.

New York Academy of Sciences. Transactions March, April, and May, 1891, and Index to Annals.

Penology, Papers in. Second Series. New York State Reformatory. Pp. 148.

Pick, Dr. E. Method of acquiring the French Language. Syracuse, N. Y.: C. W. Bardeen. Pp. 118. $1.

Pickering, Edward C. Preparation and Discussion of the Draper Catalogue. Cambridge, Mass.: John Wilson & Son. Pp. 192.

Raum, Green B. Report of the Commissioner of Pensions. 1891. Pp. 84.

Ridgway, Robert. Note on Pachyrhamphus Albinucha, Burmeister. Pp. 2.—Two Supposed New Forms of Thamnophilus. P. 1.—Notes on some Birds from the Interior of Honduras. Pp. 5.—On some Costa Rican Birds. Pp. 6.—On the Genus Sittasomus of Swainson. Pp. 4.

Rotch, A. Lawrence. Observations made at the Blue Hill Meteorological Observatory, Mass., in 1890. Cambridge, Mass.: John Wilson & Son. Pp. 120.

Sage, J. R. Annual Report of Weather and Crop Service of Iowa. Pp. 94.

Shufeldt, Dr. R. W. Amateur Photographers assisting Science. Pp. 5.—Tertiary Fossils of North American Birds. Pp. 4.

Skidmore, S. T. Thirty Lessons in Astronomy. J. B. Lippincott Co. Pp. 45.

Smith, J. Bucknall. Wire; its Manufacture and Uses. New York: John Wiley & Sons. Pp. 347.

Steineger, Leonhard. Cubital Coverts in Birds of Paradise and Bower Birds. Pp. 2.—Sceloporus Variabilis and its Geographical Distribution in the United States. Pp. 4.—New North American Lizard of the Genus Sauromalus. Pp. 3.—Some North American Snakes. Pp. 5.—Japanese Birds in the Imperial Museum, Tokio. Pp. 10.

Thompson, Edward P. How to make Inventions. New York: D. Van Nostrand Co. Pp. 161.

Troy, Daniel S. Molecular Motion in the Radiometer, in Crookes Tubes, etc. New York: N. D. C. Hodges. Pp. 61.

Upham, Warren. Geographic Limits of Species of Plants in the Basin of Red River of the North. Pp. 32.

Virginia Pharmaceutical Association. 1891. Pp. 58.

Watts, Charles A. The Agnostic Annual for 1892. London. Pp. 58. 6*d*.

Whiting, Harold. Experiments in Physical Measurement. Part IV. D. C. Heath & Co. Pp. 324.

Whitman, C. O., and Allis, E. P. Journal of Morphology. September, 1891. Ginn & Co. Pp. 120, with Plates.

Wood, H. T. Light: an Elementary Treatise. Macmillan & Co. Pp. 147. 75 cents.

POPULAR MISCELLANY.

Changes in the Grammar-school Programme.—The Association of Colleges in New England, at its last annual meeting, November 5 and 6, 1891, resolved to recommend for gradual adoption the following changes in the programme of New England grammar schools: 1. The introduction of elementary natural history into the earlier years of the programme as a substantial subject, to be taught by demonstrations and practical exercises rather than from books. 2. The introduction of elementary physics into the later years of the programme as a substantial subject, to be taught by the experimental or laboratory method, and to include exact weighing and measuring by the pupils themselves. 3. The introduction of elementary algebra at an age not later than twelve years. 4. The introduction of elementary plane geometry at an age not later than thirteen years. 5. The offering of opportunity to study French, or German, or Latin, or any two of these languages, from and after the age of ten years. In order to make room in the programme for these new subjects the Association recommends that the time allotted to arithmetic, geography, and English grammar be reduced to whatever extent may be necessary. The Association makes these recommendations in the interest of the public-school system as a whole; but most of them are offered more particularly in the interest of those children whose education is not to be continued beyond the grammar school.

The British Association.—The meeting of the British Association in August at Cardiff does not appear to have been as fully attended or as interesting as some of the preceding meetings. The week was a very rainy one, and that, no doubt, diminished to a considerable extent the number of visitors. The total attendance was about fifteen hundred, or two hundred less than that at the Leeds meeting, which was under the average. But, by virtue of an unusually large accession of life-members, the funds at the disposal of the Association for scientific purposes were almost equal to those available at Leeds. From a scientific point of view, Nature remarks, the meeting may

be said to have come up to a fair average. The presidential address of Dr. Huggins was a learned and able exposition of the spectroscopic and photographic investigation of the sky and of the results accruing from it. The addresses of the presidents of sections were mostly historical or special in character, and lacked the abundance of features of living interest that have marked some of the like addresses in past years. In the Section of Physics and Astronomy Prof. Lodge described his investigations as to the behavior of the ether in the presence of rapidly moving bodies, which, without leading to determinate results, indicated that the ether was not affected by them. A noteworthy paper read in this section was that of Prof. H. A. Newton on The Action exercised by the Planets on the Meteorites of our System. In the Chemical Section Prof. Roberts Austen invoked more attention to the metallurgical branch of the subject, and presented the problems, practical and scientific, with which the metallurgist has to deal. The alloys especially were spoken of as offering a profitable field, and "traces" as possibly having a more important bearing on the properties of the substances in which they are found than has been supposed. The address of Prof. Rupert Jones in the Geological Section related to coal, and showed that further investigation is still desirable in tracing the true origin of the coal-beds, and the ages to which their materials originally belonged. Francis Darwin spoke in the Botanical Section on Growth Curvatures in Plants, and gave the results of his long and minute investigations on the subject. Mr. E. G. Ravenstein presented to the Geographical Section an account of the progress of cartography and a justification of geography as a distinct and profitable branch of inquiry. Some of the most interesting papers read at the meeting were presented in this section by women: an account of her journey to Kilima Njaro, by Mrs. French Sheldon, and Mrs. Bishop's (Miss Isabella Bird) account of her observations in the Bakhtiari country. Prof. Cunningham, in the Section of Economics, stated some problems of high importance in that science; while in the Mechanical Section Mr. Foster Brown's address dealt mainly with details as to recent mechanical inventions; and Prof. Max Müller, in the Section of Anthropology, demonstrated the complexity of the problems of ethnical relationships, and showed that no one class of data, whether of language or physiology, or other, is competent alone for their solution. The next meeting of the Association will be held at Edinburgh, with Sir Archibald Geikie as president, August 3, 1892.

Tests of Paper.—Paper lends itself to many frauds which it is of interest to be able to detect; and it is desirable to know how to measure its principal quality—resistance to tearing. The processes for determining these conditions are very simple. There are also special details with which few are acquainted. Important differences are noted between machine-made and hand-made paper. In machine-made paper the resistance to tearing and the quality of extensibility vary according as the force is exerted lengthwise or crosswise; the difference is in the proportion of two to five. The resistance is greater in the direction of the length, while extensibility is greater in that of the breadth. The differences are explained by the method of making paper by machinery. The veins of fluid running out from the reservoir extend themselves along the metallic network without any real tendency to associate themselves closely with the neighboring veins, while the current lengthens the fibers and felts them in the direction of the length. In hand-making, the paper is homogeneous, equally resistant in both directions—a demonstration of the superiority of hand-work. There is no drawing out and felting in one direction, to the exclusion of the other; but the felting is equally distributed over the whole surface. Machine-made papers can not be stretched much in the direction of their length, for the method of fabrication has already stretched them to near the extreme limit of extension. The simplest means of testing the durability of paper as against the usual mechanical agents of destruction is rubbing it between the hands. After such treatment poor paper is full of cracks and holes, while strong paper simply takes the appearance of leather. The experiment also tells something of the composition of the paper. If much white dust is produced, we know that the paper contains earthy impurities;

if it cracks, that it has been bleached too much. The thickness of paper can be measured by putting a number of leaves together, or by the micrometrical determination of the effect of adding a single leaf to the mass. We may burn the paper and examine the ashes. If they amount to more than three per cent, clay, kaolin, spar, or gypsum has been added to the pulp. When we color paper with an iodine solution, yellow indicates the presence of wood-fiber; brown, of cotton or linen; and the absence of coloration, of cellulose.

Man's Agency in the Extermination of Species.—Extermination is defined in Nature as indicating that in certain parts of the range of a species, whether plant or animal, it has ceased to exist, however abundant it may remain elsewhere; while in other cases, especially if the species have but a limited distribution, it easily becomes equivalent to extirpation. The older school of zoölogists seem hardly to have contemplated the possibility of a whole species having become extinct within the period since man appeared upon earth, or to have supposed that a species could by human efforts be utterly swept away. Thus there was once skepticism about the extinction of the dodo, or, that having been established, about its having existed within the human period. The disappearance of numerous animals, formerly abundant, from the settled parts of our country, affords examples of local extinction; and the fate of the buffalo threatens to furnish an instance of total extinction by the agency of man. Man's agency usually acts indirectly—as by changing the conditions of the country, so as to make them unfavorable to the subsistence of certain animals, rather than directly by killing all the individuals of a species outright. The wolf has defied all efforts, by offering bounties and otherwise, to accomplish its destruction in Europe, except in artificially-built-up Holland, where it never was at home; Denmark, every spot of which is accessible to the hunter; and the United Kingdom, where its forest resorts have been removed. Other instances are the extirpation of the quail in New Zealand by means of fires that were lighted for other purposes; the threatened destruction of other interesting animals of Australia and New Zealand by animals of the weasel kind that were introduced to prey upon the imported rabbits; and the destruction of turkey-buzzards' eggs and petrels in Jamaica by the mongooses that were taken there to make war upon rats; of the *Diablotin* petrel of Dominica by a species of opossum; and the destruction of the *cahows* in the Bermudas, till it is not known now whether the bird exists there. The great *skua*, or "bonxie," disappeared from one of its three breeding-stations in the Shetland Islands several years ago, and has been maintained at the other two only through the vigorous exertions, to repress poachers and preserve it, of the late Dr. Robert Scott and the late Dr. Lawrence Edmondston, respectively. The Zoölogical Society has ordered medals struck in honor of the services these gentlemen rendered to science. Though the reward is posthumous, and goes to the heirs of the well-doers instead of to themselves, the acknowledgment is a fitting one, marks an example, and is an encouragement to the lovers of living nature.

Prof. Wright in the British Association.—Prof. G. F. Wright's paper in the British Association, on The Ice Age of North America and its Connection with the Appearance of Man on that Continent, is spoken of in Nature as a most interesting one. The author said that the glacial deposits, transported from several centers mostly outside the Arctic Circle, and the absence of a polar ice-cap, militated against an astronomical and for a geographical cause of the great cold, particularly as an uplift of the glaciated area was coincident with an important subsidence in Central America. He regarded the so-called "terminal moraine of the second period" as a moraine of retreat due to the first glaciation, and thought that the evidence of forest beds, mainly to the south of the area, indicated local recessions of ice, and not a single great interglacial epoch. Palæolithic remains similar to those of the Somme and Thames have been found in several gravel terraces flanking streams which drain from the glaciated region, and made up of glacier-borne detritus; they are regarded by the author as deposits of the floods which characterized the closing portions of the Glacial period. The recession of the falls of Niagara and St. Anthony

gives an antiquity of not more than ten thousand years to the end of the Glacial epoch—a conclusion supported by the enlargement of post-glacial valleys and the silting up of small post-glacial lakes.

Determination and Cultivation of Bacteria.—Many scores of bacteria, says Prof. John B. Roberts, in an address on the Relation of Bacteria to Practical Surgery, have been, by patient study, differentiated from their fellows, and given distinctive names. Their nomenclature corresponds in classification and arrangement with the nomenclature adopted in different departments of botany. Thus we have the pus-causing chain-coccus (*Streptococcus pyogenes*), so called because it is globular in shape; because it grows with the individual plants attached to each other, or arranged in a row, like a chain of beads on a string; and because it produces pus. In a similar way we have the pus-causing grape-coccus of a golden color (*Staphylococcus pyogenes aureus*). It grows with the individual plants arranged somewhat after the manner of a bunch of grapes, and, when millions of them are collected together, the mass has a golden-yellow hue. The difficulty of investigating these minute forms becomes apparent when it is remembered that under the microscope many of them are identical in appearance, and it is only by observing their growth when they are in a proper soil that they can be distinguished from one another. In certain cases it is difficult to distinguish them by the physical appearance produced during their growth. Then it is only after an animal has been inoculated with them that the individual parasite can be accurately recognized and called by name. It is known, then, by the results which it is capable of producing. Bacteria may also be distinguished by their individual peculiarities of taking certain dyes. The similarity between bacteria and ordinary plants with which florists are familiar is remarkable. Bacteria grow in animal and other albuminous fluids; but it is as essential to them to have a suitable soil as it is for the corn or wheat that the farmer plants in his field. By altering the character of the albuminous fluid in which the microorganism finds its subsistence, these small plants may be given a vigorous growth, or may be starved to death. The farmer knows that it is impossible for him to grow the same crop year after year in the same field, and he is, therefore, compelled to rotate his crops. So it is with the microscopic plants which we are considering. After a time the culture-field or soil becomes so exhausted of its needed constituents, by the immense number of plants living in it, that it is unfit for their life or development. Then this particular form will no longer thrive; but some other form of bacteria may find in it the properties required for functional activity and may grow vigorously. Again, there are certain bacteria which are so antagonistic to each other that it is impossible to make them grow in company or coexist in the blood of the same individual. An animal inoculated with erysipelas germs can not be successfully inoculated immediately afterward with the germs of malignant pustule. As the horticulturist is able to alter the character of his plants by changing the circumstances under which they live, so can the bacteriologist change the vital properties and activities of bacteria by chemical and other manipulations of the culture-substances in which these organisms grow. The power of bacteria to cause pathological changes may thus be weakened and attenuated; in other words, their functional power for evil is taken from them by alterations in the soil, and *vice versa*.

Properties of Peroxide of Hydrogen.—Peroxide of hydrogen has been a subject of experiment by Dr. B. W. Richardson, chiefly with regard to its medical uses, for more than thirty years. He regards it as a solution—although it may be made to take on the gaseous form—and as consisting of water containing, according to strength, so many atmospheres of oxygen; or as an oxygen atmosphere in solution. It is not, however, a mere mixture, but a peculiar chemical compound. The oxygen can be made to accumulate, volume by volume, until the volume of water can rise to ten, twenty, thirty, and some say even more than a hundred volumes of oxygen, before complete saturation is reached and a volatile body is formed. The combination of the added oxygen in hydrogen peroxide is stable in the presence of some substances, unstable and easily evolved in the

presence of others. Some substances, inorganic or organic, when added to the solution, are neutral; others evolve the oxygen and are themselves unchanged; a third kind evolve the oxygen, and with that some of their own contained oxygen; and a fourth kind absorb the oxygen. Thus, with oxide of iron there is no action; with black oxide of platinum a taper can be lighted from the oxygen thrown off; with permanganate the action is very brisk, and oxygen is thrown off from both substances; and arsenious acid absorbs oxygen from the solution. Dr. Richardson has found peroxide of hydrogen useful in a large number of diseases; among them are consumption, whooping-cough, ulcers and purulent exudation, syphilis, diabetes, anæmia, rheumatism, and others, his experiments with which, and his methods of application, are described in a paper recently read by him before the Medical Society of London.

Origin of Caste.—The origin of caste in India was traced by General T. Dennehy, in the International Oriental Congress, probably to the contact of the Indo-Aryans on their first migration with the uncouth, uncivilized aborigines of the countries which they traversed. The Aryans were even then highly civilized and careful as to personal cleanliness and religious observances, and naturally shrunk against contact with the unwashed aborigines. They were particularly so with regard to food, and hence arose the first manifestations of caste in the exclusion of strangers from their meals. This custom grew with years to be a cherished observance, and what was first a measure of hygienic precaution became an article of religious belief. The later developments of caste corresponded with the guilds of European countries so prevalent in the middle ages. New castes were seen growing up in India as new necessities arose. For example, since the establishment of railroads it had been necessary to find pointsmen (switchmen) and firemen; and these men, being anxious to preserve the emoluments of their posts in their own families, were now actually crystallizing into a new caste. The views expressed by M. C. A. Pret, though differing from these, were not inconsistent with them. He discerned the working of evolution in caste. The Indo-Europeans formed at an early period a social hierarchy which continued in full force long after the language spoken by them had ceased to be a living tongue. The general ignorance prevailing in primitive times necessarily involved the evolution of a priestly or teaching caste—the Brahmins. The necessity of having men always on guard against the attacks and invasions of neighboring races with different tendencies led to the warrior class or caste. These two leading castes represented the two leading principles in the constitution of civilization—the religious and the military. The civil principle, properly so called, did not come into existence till a later period.

Little Annoyances and Health.—Such matters as water supply, sewerage and drainage, streets and pavements, including means of rapid transit, parks, and open spaces, lighting, provisions for the dead and for those affected with contagious disease, and the sale of improper food and drinks, are classed by Dr. John S. Billings, in his address on Public Health and Municipal Government, as variables under municipal control, many of which have a powerful influence on the health of the people. A large part of the discussions as to the best way to arrange and manage them, or as to whether in any particular place at a particular time the municipality is doing its duty with regard to them, turn on sickness and death-rates. It should be borne in mind, however, Dr. Billings adds, that no sharp dividing-line can be drawn between comfort and health; that there are many things—such as noise, dust, offensive odors, rough streets, etc.—the influence of which upon sickness and death-rates it would be at present difficult or impossible to demonstrate, at least to the satisfaction of a court of law, which yet add materially to the burdens of life of those who are subjected to them, and may in some instances turn the scales between life and death. The human body in some diseases may be likened to a heavy railway train going up a very steep grade. If the fire under the boiler can be kept bright and clear, if the fuel and water hold out, and the engineer is skilled and careful to get the benefit of every pound of steam power developed, then the train will just reach the top of the hill, provided there

are no little pebbles on the track. It is always difficult, and usually impossible, to obtain evidence that is satisfactory, from a legal point of view, to prove that the offensive odors from a bone-boiling establishment, or the emanations from a cess-pool, or the water from a polluted well, have produced such a definitely injurious effect upon the health of those within the sphere of their influence as to justify municipal interference with vested rights in property, or the exaction of damage for sickness or death produced by them. This has heretofore been due largely to the want of definite and precise or, in other words, scientific knowledge of the causes of disease and death.

Cyclopean Structures in Oceania.—One reason, said Mr. R. Sterndale, in the International Congress of Orientalists, why the remarkable architectural remains existing in the many islands of the Pacific have attracted relatively little attention is the idea that they are comparatively recent. The early people of the Caroline Islands were builders of Cyclopean towers and pyramids, and are still skillful in building great walls of rude stone. While many islands have been peopled by accidental castaways, the settlement of the great mountain groups was effected by organized migrations of savage navigators fighting their way from land to land, and carrying with them their families and household gods, and the seeds of plants and trees. The copper-colored autochthones of eastern Asia spread in the course of ages to the Caroline groups, and were the progenitors of the Palaos, Barbudos, Hombos, Blancos, and other families of gentle barbarians. They were followed by another exdous of a kindred race, ferocious and pugnacious, and Cyclopean builders on a large scale. Their strong castles, built on steep hills or surrounded by deep trenches, attest the frequency and destructiveness of their wars. The architecture of their temples—immense quadrangular, paved inclosures, surrounded by lofty walls and containing within them terraces, pyramids, artificial caverns and subterranean passages—illustrate their religious earnestness. Some of these structures were mausoleums as well as temples, and are spoken of by the present race of natives as sepulchres of the ancient deities. The author's brother, Mr. Handley Sterndale, had found among the mountain ranges of Upolu an enormous fort, in some places excavated, in others built up at the sides, which led him to a truncated conical structure about twenty feet high and one hundred feet in diameter. The lower tiers of stone were very large and laid in courses, with what seemed to be entrances to the inside in two places. It was probably the center of the village, as many foundations a few feet high were near it. The Samoan natives had no tradition respecting the people that may have inhabited this mountain fastness.

Slavic Marriage Forecasts.—Many curious customs are preserved among the Slavic nations from the olden time. Of these, those relating to marriage forecastings are perhaps of the most peculiar interest. In some districts maidens on Christmas Eve throw rings or melted lead and wax into a vessel full of water, and, while fishing them out, sing old songs, the verses of which foretell, as they catch each object, the peculiarities of their future husbands; or bread and money are mixed with the straw which on Christmas Eve underlies the table-cloth; and the girl who in the dark draws out money is promised a wealthy husband, while she who draws bread must give up that dream. If the counting of an armful of chips, gathered alone and in silence from the wood-house, gives an even number, the girl will find a mate; but if the number be odd she will have to live single. The young people, blindfolded and in the dark, pick from the straw with which the Christmas-Eve supper-tables are strewed for purposes of the divination. The drawing of a green sprig promises a wedding, but of a dry one, long waiting. Wine, beer, and water are placed by a girl between two candles on a table, and she retires to a corner whence she can watch in the looking-glass. If the man who is expected to come at midnight drinks the wine, her married life will be one of wealth; if he drinks the beer, she will enjoy a moderate competency; if the water is chosen, poverty awaits her. If wreaths of flowers thrown into a stream on midsummer eve float undamaged out of sight, the omen is good; but should the wreaths break, or the flowers sink before the watcher, the prospects of her future are

clouded. A maiden throws a wreath of flowers over her head backward against a tree. If the wreath catches and hangs on a branch at the first throw, the thrower will become a bride in the first succeeding year; if at the second throw, the wedding will be in the second year; and so on.

Classification of Glacial Formations.—In the discussion in the International Geological Congress on the Classification of Glacial Formations, Prof. T. C. Chamberlin proposed six classes, namely: Formations produced directly from the action of Pleistocene glaciers; formations produced by the combined action of Pleistocene glaciers and accompanying drainage; formations produced by glacial waters after their issue from Pleistocene glaciers; formations produced by floating ice derived from Pleistocene glaciers; formations produced by shore ice and ice floes, due to low Pleistocene temperature, but independent of glacier action; and formations produced by winds acting on Pleistocene glacial and glaciofluvial deposits under the peculiar condition of glaciation. In each of these classes subdivisions were proposed. Prof. Albert Gaudry led in the discussion that followed. Dr. Felix Wahnschaffe described the action of glaciers in forming moraines. W J McGee presented a scheme of classification with five general heads: Aqueous, at base-level and above base-level; Glacial, direct and indirect; Aqueo-glacial; Eolic; and Volcanic, direct and indirect.

Origin of Folk-lore Tales.—The value of folk lore is regarded by Mr. E. Sidney Harland as lying in the belief that the traditions alike of our fathers and other nations contain and may be made to yield valuable information concerning the primitive beliefs and practices of mankind, and behind these, concerning the structure and development of the human mind. It is chiefly in tales that the speculative portions of a savage creed take shape. Not a little has been done in this direction since Grimm first showed the remains of ancient heathendom in the stories of his own land. Grimm's method has been more widely applied in recent years by distinguished writers to stories found in every region, and conclusions in regard to the beliefs fundamental to all savage religions have been based in part upon them. Those speculations have not been allowed to pass unchallenged. Literary men have contended that the true origin of folk tales is to be found in India, and that they were originally Buddhist parables sowed broadcast by the Buddhist propaganda. But this theory has been weakened by the discovery of streams of Egyptian and even of Jewish tradition flowing through the tales; and as the area of research widened, it was more and more doubted that folk tales found in the remotest corners of the earth all sprang from one center within a measurable historical period. The anthropological theory attributed the origin of folk tales, as of every other species of tradition, to the constitution of the human mind. A similar environment acting upon the mind would everywhere produce similar results; and it is the variations of the environment which give rise to the stories all presenting perpetual coincidences, and all evolved from a few leading ideas common to the race. The birthplace can not therefore be determined, for no story has any one birthplace. Another theory admits that the foundations of the absurd and impossible tales current all round the globe must be sought in the beliefs of savage tribes about themselves and their surroundings, but denies that the mere fact that a given story is found domesticated among any people is of itself evidence of the beliefs and practices of that people, present or past. Some stories must have been invented once, and once only, and then handed on from man to man, from tribe to tribe, till they had made the circuit of the world. This is the dissemination theory, while the other is the anthropological theory. Mr. Harland sustains the anthropological theory.

Nature of the Ether.—Speaking of the theory and function of the ether, Prof. Nipher said in the American Association that the slowing up of light in space occupied by matter shows that the ether within must be either more dense (as Fresnel believed) or less elastic than that existing in free space. It is certainly very difficult to understand what there can be in the molecules of matter that can increase the den-

sity of an incompressible medium. The experiments of Michelson and Morley show apparently that the ether at the surface of the earth moves with it. It is dragged along as if it were a viscid liquid. The field of a steel magnet is, however, a rotational phenomenon. It is a spin which is maintained permanently without the expenditure of energy. It seems, therefore, that the resistance to shear which shows itself in the adhesion of the ether to the moving earth must be a rigidity due in some way to motion. Other experiments of Michelson and Morley on the motion of light in moving columns of water have been taken as proof that the ether in water is condensed to nine sixteenths of its volume in air. The ether in water certainly behaves as if it were more dense, but it is another matter to say that it is so. It seems improbable. The speaker, after describing what might be a more satisfactory way of making the experiment, said that the question to be settled is whether the ether or any part of it is at rest in space, or does it sweep through the interior of bodies that move through it as wind sweeps through the leaves and branches of a tree.

NOTES.

We mention, on behalf of Mr. Frederick Starr, that the originals of most of the objects illustrated in his articles on Dress and Adornment are in the American Museum of Natural History. The omission of this acknowledgment from the articles was not noticed till it was too late to correct it.

The Programme of Lectures of the Franklin Institute, Philadelphia, provides for thirty lectures, beginning November 2d with a lecture on Japan by Mr. Henry Pettit. Several of the lectures will be upon subjects of travel. For the others, subjects are announced relating to the electrical transmission of power, physical exercise, compressed air power, transmission of explosive phenomena, building-stones, refrigerating machines, and other topics relating to hygiene, metallurgy, applied chemistry, etc. The lecturers are men specially acquainted with the subjects which they will treat.

We have received from F. Gutekunst, 712 Arch Street, Philadelphia, a remarkably fine half-size photograph of the late Joseph Leidy. In distinctness of outline, clearness of expression, delicacy of shading, and general tone, it leaves nothing to be desired.

Certain prehistoric remains near Bellary, in southern India, described by Mr. F. Fawcett in the International Congress of Orientalists, are particularly remarkable by reason of the pictures which are engraved on the rocks in their neighborhood, and which the author adduces many reasons for believing to be prehistoric. A commission was appointed by the Congress to make further investigation of the matter.

A tree-climbing kangaroo from Northern Queensland (*Dendrolagus Muelleri*), new to science, is described by Messrs. Luehman and French. It has a body about two feet long, with a tail exceeding two feet. The disproportion between the fore legs and the hind legs is not nearly so great as in the ordinary kangaroo and the wallaby. The toes are strong and curved, so that it is able to climb tall and straight trees, where it lives on their leaves. The specimen from which the species is described was got from a straight tree, about ninety feet from the ground.

A marsupial mole—*Notoryctes typhlops*—a species absolutely new to science, has been discovered living in the sands and among the porcupine grass of South Australia. It is very rare and has been seen by only a few persons, either white men or natives. Perpetual burrowing seems to be the characteristic feature of its life. It burrows very rapidly, but is not known to occupy permanent burrows. The first specimen was captured by Mr. William Conethard, of the Willowie Pastoral Company, and the description is by Prof. Stirling, of the University of Adelaide.

The Bowlder Committee of the British Association reports that in some districts bowlders are being destroyed so rapidly that many described in former reports have disappeared.

Among the features of the Columbian Exhibition to be opened at Madrid in September, 1892, will be an American historical exposition, which is intended to reproduce the condition of the different countries of the new continent before the arrival of Europeans, at the time of the conquest, and down to the first half of the seventeenth century. It will include all kinds of objects, models, reproductions, plans, etc., relating to the peoples who inhabited America then and to all those who had to do with the navigators.

Mr. Ivan Petroff, special census agent in Alaska, has found six hundred natives on Nunivak Island, where there were supposed to be three hundred. They live, in the absence of white men, in the most primitive style, eating walrus flesh and possessing walrus ivory as their only wealth. Besides a few land otter they do not catch any fur-bearing animals.

In the Congress of German Naturalists and Physicians, Prof. Lehman showed to how great an extent the coarse rye-bread eaten on the lower Rhine is polluted by adulteration. He had procured eighty samples of flour and bread such as are used and sold by the small millers and bakers. All of them were polluted, some to an incredible extent, with earth, excrement of mice, other disgusting but not exactly noxious things, and also with blighted corn, darnel, cockle, and other poisonous seeds. None of the samples were free from cockle, and in some there was more than one per cent of it.

In the matter of Technical Education in Connection with Agriculture in England, Mr. S. Rowlandson has shown that under the stimulation of a parliamentary grant the Royal Agricultural Society has instituted examinations in the science and theory of agriculture, a provision for the teaching of elementary agricultural subjects has been incorporated in the education code, and attention has been given to the matter by the Universities of Oxford and Cambridge. The lack of teachers is the chief obstacle to making the benefits of instruction in the subject real and general.

On the occasion of the transit of Mercury, May 10, 1891, Dr. K. Winder, of Detroit, analyzing the solar spectrum at the point where the planet was projected on the sun's disk, observed that the telluric rays in the light from the edge of the planet were strongly marked and extraordinarily dark, indicating the existence of a dense atmosphere in Mercury and the presence of vapor in it.

Finnic and Russian Lapland constitute one of the coldest regions of Europe. The whole country is within the isotherm of 0° C., while in its interior the isotherms of —1° and —2° describe concentric curves. At Kola the thermometer stands above 0° C. (the freezing-point) only during three months. The winter usually begins on the 15th of September. The long winter, ending in June, is followed by a spring of fifteen days; then summer begins in the first week in July and lasts some six or seven weeks, when the thermometer often shows a considerably warm temperature. In the neighborhood of Enasa the ranunculus blossoms on the 28th of June, chickweed July 3d, meadow geranium July 12th, blackberry July 26th, azalea June 26th, *Linnea borealis* July 20th, and butterwort July 2d.

As a test for the detection of fish oil in linseed oil, Dr. Thomas Taylor recommends silver nitrate solution. On its application the fish oil, if any is present, coagulates and falls to the bottom of the test-tube, displacing the nitrate-of-silver solution. The author declares the test infallible, as the effect is not produced with other oils.

Dr. L. Webster Fox believes from his experiments that savage races have better color-perceptions than civilized races. In a group of one hundred Indian boys he found none color-blind. In another group of two hundred and fifty Indian boys two were color-blind. No color-blind Indian girls were found.

A curious instance of "frugality" in bees has been observed by Mr. M. H. Harris, of Ealing, England. During rainy weather, which promised to interfere with further honey-making, they proceeded to guard against it by ejecting the larvæ of both drones and workers and sucking out the soft contents of the corpses, leaving only the white chitinous covering.

OBITUARY NOTES.

Cardinal Haynald, Archbishop of Kalocsa, who died on the 4th of July last, was the son of a botanist and made himself eminent in that science by his investigations of the flora of Transylvania. Even among his sacerdotal duties and his political ones as member of the Hungarian House of Magnates, and the social obligations they imposed, he found time to continue his botanical studies and publish a few special papers and biographical studies of botanists of his acquaintance. His herbarium was the richest in Hungary and one of the largest private collections on the continent, and was free to students.

The death of two well-known contributors to French scientific journals was announced in the same week in October. M. Edouard Lucas, Professor of Special Mathematics at the Lycée Charlemagne, died of erysipelas following a wound in the cheek made by a piece of a broken dining-plate. He had just been presiding over the Section of Mathematics and Astronomy of the French Association for the Advancement of Science. He was the author of a series of curious mathematical recreations and recondite calculations—as amusing as they were instructive—of which the most famous was that of the Tower of Hanoi. He frequently contributed articles of this character to the Revue Scientifique and La Nature. M. Félix Hément had been Professor of Physics and Natural Science at Tournon, Strasbourg, the Lycée Bonaparte, the Collége Chaptal, the École Turgot, the École Polonaise, and the Israelitish Seminary. He was also a frequent contributor to La Nature and the Revue Scientifique.

Mr. Charles Smith Wilkinson, Government Geologist of New South Wales, died August 26th, forty-seven years old. He was an original member of the Linnæan Society of New South Wales, and its president in 1883 and 1884.